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Regional Strategies for Managing Threatened and Endangered Species Habitats: A Concept Plan and Status Report

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Improving Mission Readiness through Environmental Research

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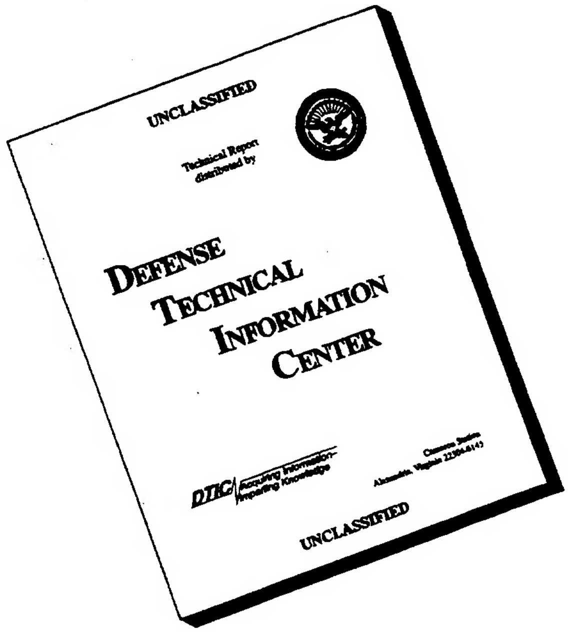

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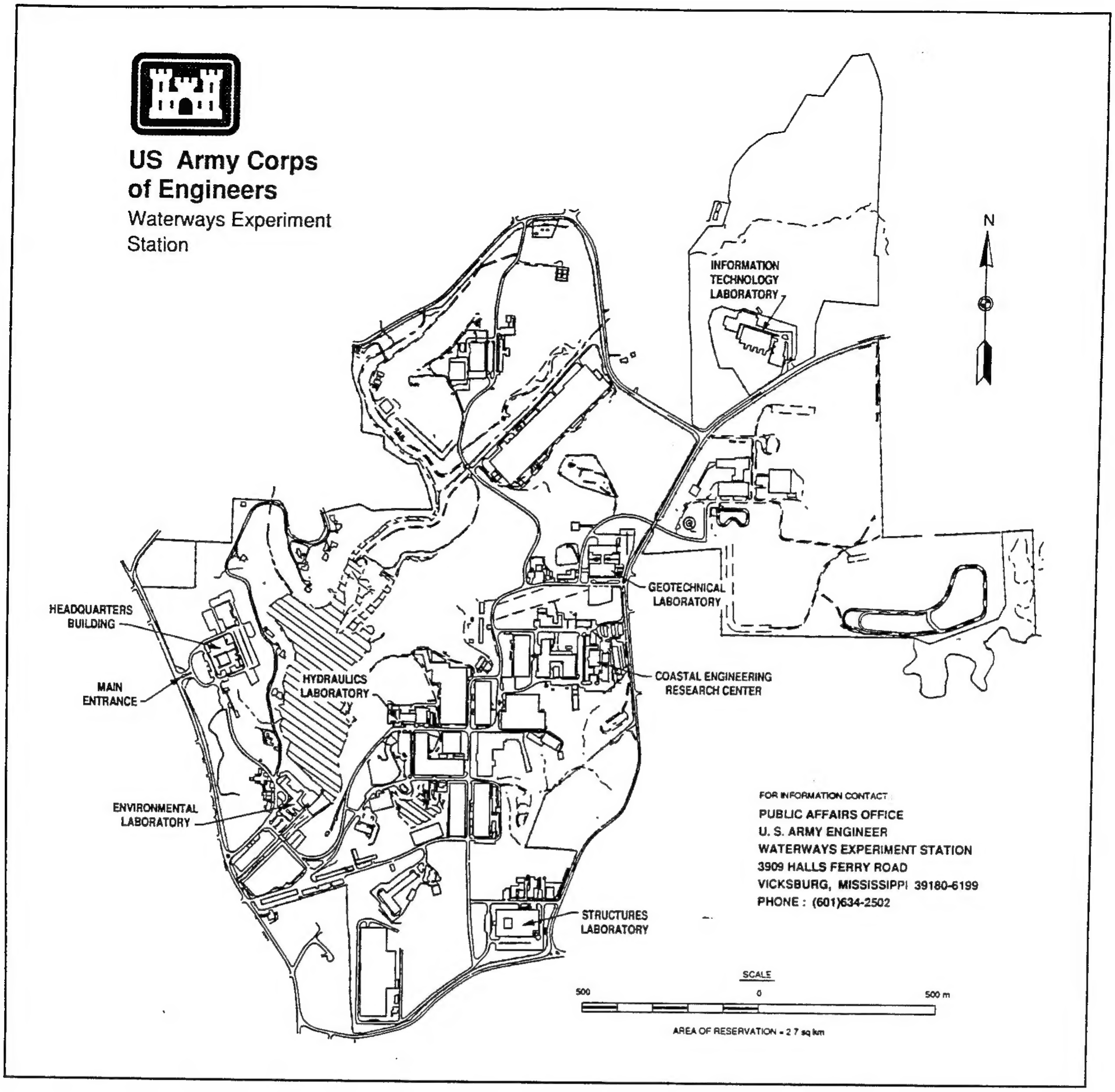

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Preface

The work described herein was authorized by the Strategic Environmental Research and Development Program (SERDP), Washington, DC. The work was performed under the SERDP study entitled "Regional Guidelines for Managing Threatened and Endangered Species Habitats." Dr. John Harrison is Acting Executive Director, SERDP. The program is managed by Labat-Anderson, Inc., Arlington, VA.

This report was prepared by Mr. Chester O. Martin and Dr. Richard A. Fischer, Natural Resources Division (NRD), Environmental Laboratory (EL), U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, and Ms. Mary G. Harper, Dr. David J. Tazik, and Ms. Ann-Marie Trame, Natural Resource Assessment and Management Division, Land Management Laboratory, U.S. Army Construction Engineering Research Laboratories (CERL), Champaign, IL. Dr. Fischer was employed by WES under an Intergovernmental Personnel Act Contract Agreement with the University of Idaho, Moscow, ID, during the preparation of this report. Ms. Harper was employed as a Research Associate under an interagency agreement with the U.S. Forest Service, Rocky Mountain Range and Forest Experiment Station, and Colorado State University.

Numerous Department of Defense (DoD) and non-DoD personnel contributed information and provided recommendations for this report. Report review was provided by Mr. Hollis H. Allen, Dr. Wilma A. Mitchell, and Mr. Michael R. Waring, WES; Drs. David Price and Alison Hill, CERL; Dr. Darryl Calkins, U.S. Army Cold Regions Research and Engineering Laboratory; Mr. Peter Boice, Office of the Deputy Undersecretary of Defense, DoD; Mr. Phil Pierce, Office of the Director of Environmental Programs, Department of Army (DA); Dr. Edward W. Novak, Army Environmental Policy Institute; COL Scott C. Marcy, Office of the Deputy Chief of Staff for Operations and Plans, DA; Messrs. Rich Clewell, William E. Woodson, James W. Delk, and Thomas Vorac, Headquarters (HQ), Army Material Command; Mr. Bob Anderson, HQ, Training and Doctrine Command, DA; Mr. Bert Bivings, HQ, Forces Command, DA; Dr. Marc Imlay, HQ, National Guard Bureau, DA; Dr. John Bushman, HQ, U.S. Army Corps of Engineers; LTC Tom Lillie and Dr. J. Douglas Ripley, HQ, U.S. Air Force; Mr. James Omans, HQ, U.S. Marine Corps; Dr. Warren W. Webb, U.S. Department of Energy; Ms. Merrily Severence, HQ, U.S. Navy;

Dr. Renn Lohoefener, Dr. David Flemming, and Mr. David L. Martin, U.S. Fish and Wildlife Service; and Mr. Keith O. Eggleston, U.S. Department of Interior Bureau of Reclamation.

Mses. Lesley Deem-Dickson and Dezera Davis, CERL, and Messrs. Larry A. Reynolds and John J. Lane, WES, provided valuable technical assistance and contributed information to the appendixes. Ms. Tiffany A. Cook, Ms. Fitima Cooke, Mr. Paul K. Kim, and Mr. Chalin B. Street, WES, assembled species information, conducted literature surveys, and entered information into computerized databases. Mr. John G. Giudice and Dr. John T. Ratti, University of Idaho, provided information on ecological regionalization schemes.

This report was prepared under the general supervision of Mr. Hollis H. Allen, Acting Chief, Stewardship Branch, NRD, EL; Dr. Robert M. Engler, Chief, NRD, EL; and Dr. John W. Keeley, Director, EL.

At the time of publication of this report, Dr. Robert W. Whalin was Director of WES. COL Bruce K. Howard, EN, was Commander.

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1 Introduction

A concept plan and status report is provided herein for the Strategic Environmental Research and Development Program (SERDP) work unit "Regional Guidelines for Managing T&E Species Habitats." The project, originally entitled "Development of Regional Guidelines for Evaluating and Managing T&E Species on DoD Lands," was proposed and funded as part of the SERDP program in Fiscal Year 1993 (FY93). The title was later modified to comply with revised reporting procedures. In this report, the term "guidelines" is replaced with "strategies" to better reflect the study concept.

The conservation and management of Threatened and Endangered Species (TES)[1,2] and their habitats are recognized as major concerns on Department of Defense (DoD) installations nationwide. To date, most efforts to address TES issues have been conducted on a species-by-species basis on separate installations. Also, various methods and information have been used by different installations to determine TES monitoring and management requirements. Consequently, there is considerable unnecessary duplication of effort, and methods for evaluation and monitoring are often inconsistent. Reliable procedures are needed to evaluate TES habitats and manage available resources to provide optimal conditions for a variety of species on DoD lands.

The goal of this project is to provide DoD with improved capability for making informed and cost-effective decisions regarding TES management. It represents a joint effort by the U.S. Army Engineer Waterways Experiment Station (WES) and the U.S. Army Construction Engineering Research Laboratories (CERL). Extensive coordination will also occur with other Federal agencies such as the U.S. Department of Interior (USDI) Fish and Wildlife Service (USFWS), USDI National Biological Service (NBS), and U.S. Department of Agriculture (USDA) Forest Service (USFS).

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1 The acronym "TES" instead of "T&E Species" will be used in this report to conform to standard DoD terminology. Also included are Candidate Species (former C1 species), defined as those plant and animal species that, in the opinion of the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service, may qualify for listing as threatened or endangered pursuant to the Endangered Species Act; and "Species At Risk," or former "C2" species. Complete USFWS definitions for TES are provided in Table 1.

2 Fishes and invertebrates are currently excluded because they are beyond the scope of this study.

Table 1
Federal Definitions of Status Categories for Endangered, Threatened, and Candidate Species (50 CFR Part 17, USFWS 1994a) and Species at Risk in the United States

Federal Designation	Definition
Endangered (E)	"Any species which is in danger of extinction throughout all or a significant portion of its range."
Threatened (T)	"Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."
Proposed Endangered (PE)	"Taxa already proposed to be listed as endangered."
Proposed Threatened (PT)	"Taxa already proposed to be listed as threatened."
Candidate Species[1] (C)	The former C1 species defined as "Taxa for which the Service has on file enough sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species. Proposed rules have not yet been issued because this action is precluded at present by other listing activity."
Species at Risk[1] (SAR)	The former C2 species which were defined as "Taxa for which information now in the possession of the Service indicates that proposing to list as endangered or threatened is possibly appropriate, but for which persuasive data on biological vulnerability and threat are not currently available to support proposed rules. The Service emphasizes that these taxa are not being proposed for listing by this notice, and that there are no current plans for such proposals until additional supporting information becomes available." The USFWS is actively discussing how best to identify future candidates from the large pool of former C2 candidates.

[1] U.S. Fish and Wildlife Service Memorandum. Subject: Policy on Candidate Assessment and Petition Management Under the Endangered Species Act. Mollie Beattie, Director, USDI Fish and Wildlife Service, 19 July 1995.

Objectives

This project is designed to provide a regionalized approach to TES management on DoD lands. The primary technical objective is to develop strategies for assessing and managing TES and their habitats, emphasizing (a) regional and community-based strategies, (b) methods that apply collectively to several species (instead of single species), and (c) use of consistently reliable methods within geographic regions. Although consistency is desirable, there is need for flexibility in methods due to subregional variation in biotic and abiotic factors. Major components of this approach are as follows (specific technical components are further discussed under the Concept Plan (Chapter 2):

- Compile available information on TES occurring on installations in selected regions.

- Assess habitat requirements for selected species.

- Develop management and monitoring strategies that apply collectively to species within plant communities.

- Assess potential impacts of military operations on species and their habitats.

- Develop a prototype community-based assessment and management plan.

The benefit to installations will be (a) information on available, up-to-date TES management practices and any known effects on rare species; (b) reduction of unnecessary duplication of effort among installations; (c) significant cost savings over time; and (d) improved credibility of DoD TES efforts. Potential users include all DoD installations with known or probable populations of TES. The project also has widespread application to other Federal and State agencies.

Military Lands

The DoD is responsible for an impressive land base known to support a variety of natural resources. The U.S. Army manages nearly 5 million ha of land on approximately 120 major military installations throughout the United States, and more than 400,000 ha of State and Federal lands are used by the Army National Guard (Tazik and Pierce 1994). The U.S. Navy has approximately 800,000 ha on 200 installations with natural resources management responsibilities; many of these are located in coastal areas near urban centers, and half are less than 800 ha (Egeland 1994). The U.S. Air Force is composed of more than 100 installations and training ranges on approximately 3.6 million ha of land worldwide (Lillie 1994). The U.S. Marine Corps manages over 630,000 ha of land on 23 installations.[1] The Army also manages 4.7 million ha of land and water on approximately 460 Corps of Engineers projects (Klesch, Bushman, and Martin 1994). However, TES concerns on Corps lands are not specifically addressed in this study. Nonetheless, information presented will have widespread application to Corps projects and other Federal lands.

Over 100 Federally listed species and nearly 200 candidates and species at risk are known or expected to occur on Army military lands (Tazik and Pierce 1994); 24 Federally listed species have been documented for Army National

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1 Personal Communication, 1995, James Omans, Headquarters, U.S. Marine Corps, Washington, DC.

Guard training areas.[1] Egeland (1994) reported that Navy lands are known to host 164 threatened and endangered species and potentially host another 231 endangered species (this figure is assumed to include candidates and species at risk). Over 70 listed species have been documented on Air Force lands (Lillie 1994). Based on data tabulated by The Nature Conservancy (TNC), it appears that DoD harbors a disproportionate number of listed species relative to the land base (9.4 species/million ha) compared with that of other Federal agencies (1.0 to 3.2 species/million ha) (Tazik and Pierce 1994).

Although military installations represent only a fraction of all Federal lands, these land holdings are ecologically significant because they provide refugia for a broad spectrum of rare and endangered plants and animals. However, many of these installations have become habitat islands due to urban and agricultural encroachment. Thus, extant rare species populations have become increasingly isolated from regional populations and are subject to an increased probability of local extinction.

TES Military Strategy

The Office of the Deputy Under Secretary of Defense (Environmental Security), Conservation Division (ODUSD[ES]EQ-CO), is responsible for policy development and program oversight for the Military Departments' conservation programs, including TES (Boice 1994). Environmental research within the DoD is planned, programmed, and conducted via the Tri-Service Reliance Program. This program establishes lead services for the major environmental research and development (R&D) program areas. The Army has been designated as the lead agency for conservation research, which encompasses both cultural and natural resources, including TES (Tazik and Pierce 1994).

The Department of Army (DA) recently completed preparation of the "U.S. Army Threatened and Endangered Species Research and Development Strategy and Action Plan" (Tazik and Martin 1994), which defines the Army's approach and framework for planning and conducting research directed towards TES. The Army's environmental vision, as described in the "U.S. Army Environmental Strategy into the 21st Century," establishes the framework for the TES R&D Strategy. The Strategy, in turn, supports the Army environmental vision and represents a progressive conservation posture with respect to TES and associated ecosystems. The TES R&D Strategy also embraces the "Army Strategy for the Management of Endangered Species" and recent Army TES policy provided in draft Army Regulations (AR). Chapter 11 of AR 200-3[2] details requirements and processes for complying

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[1] Personal Communication, 1995, Marc Imlay, Headquarters, National Guard Bureau, Arlington, VA.

[2] Army Regulation (AR) 200-3. Environmental Quality, "Natural Resources-Land, Forest, and Wildlife Management," Department of the Army, effective February 28, 1995.

with the Endangered Species Act (ESA). These guidelines specify development of installation TES management plans, and they encourage interagency coordination and cooperation in recovery planning and execution (Tazik and Pierce 1994).

Within DoD, there has been a recent move toward ecosystem-based management. This is a goal-driven approach to restoring and sustaining healthy ecosystems and their functions. Emphasis is also being placed on multispecies management rather than focusing on a single species of interest (Boice 1994). This is consistent with present DoD philosophies and programs. For example, a recent DoD memorandum[1] encouraged the use of an ecosystem or community-based approach to provide benefits to multiple species. This approach was also considered appropriate for developing installation Endangered Species Management Plans that involve several species (Science Applications International Corporation 1995). The concept of ecosystem management as it applies to TES on military lands is discussed in Trame and Tazik (1995).

Performers/Cooperators

This study was initially developed by WES and was submitted as a shared work unit between WES and CERL. The study will be coordinated with other DoD laboratories as appropriate, as well as with other Federal agencies, including USFWS, NBS, and USFS. Department of Energy (DOE) environmental programs and facilities, especially DOE National Environmental Research Parks, will be investigated as potential sources of regional TES information.

Several universities are also involved in the study. Contracts have been established for an Intergovernmental Personnel Act (IPA) with the University of Idaho and a Research Associate through the USFS and Colorado State University (CSU). The study has also employed contract students from the following colleges and universities: CSU, Louisiana State University, University of Illinois, Tennessee Tech University, Mississippi University for Women, University of Maryland Eastern Shore, Rhodes College, and Alcorn State University. Numerous other universities have been contacted regarding information and expertise on certain species and ecosystems.

Information from several other DoD studies is being examined to complement this project. These include the following (funding source followed by

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1 Department of Defense Memorandum. Subject: Implementation of Ecosystem Management in the DoD. Office of the Deputy Under Secretary of Defense. 8 August 1994.

performing laboratory shown in parentheses; see footnote[1] for description of Program acronyms): (a) Inventory and Monitoring of Rare, Threatened and Endangered Species on Military Lands (RDT&E, CERL); (b) TES Questionnaire (ODEP, CERL); (c) Protocols for Evaluating the Status of TES (RDT&E, CERL); (d) Biological/Environmental Assessment of the Army's Red-Cockaded Woodpecker Management Guidelines (DCSOPS, CERL); (e) Proactive Mitigation and Monitoring Strategies for Rare and Endangered Species (RDT&E, CERL); (f) Assessment of Natural Resources Managed by the Corps of Engineers (NRRP, WES); (g) Central and South Florida Ecosystem Restoration Project (reimbursable, WES); (h) Assessment of Threatened and Endangered Species Habitat on U.S. Army Armament, Research, Development, and Engineering Center at Picatinny Arsenal (reimbursable, WES); (i) Impacts of Red-Cockaded Woodpecker Guidelines on other Sensitive Species (Legacy, CERL); and (j) Regional Evaluation of DoD Natural Resources (Legacy, CERL).

[1] RDT&E = Research Development Test and Evaluation; Department of the Army Direct-Allotted Research Program; ODEP = Office of the Director of Environmental Programs, Department of the Army; DCSOPS = Deputy Chief of Staff for Operations and Plans, Department of the Army; NRRP = Natural Resources Research Program, U.S. Army Corps of Engineers; Legacy = Legacy Resources Management Program, Department of Defense.

2 Concept Plan

Historically, the military has dealt with TES concerns by managing for individual species on an installation-by-installation basis. More recently, attempts have been made to manage for groups of rare species sharing similar habitat, and on a regional basis for species that occur on multiple installations. For example, Army-wide habitat management guidelines have been developed for the red-cockaded woodpecker (U.S. Army Construction Engineering Research Laboratories 1994). Reliable methods and procedures are needed to evaluate and manage all communities supporting TES. These methods and procedures should be applicable across installations within an ecological region.

Approach

This project will emphasize a regionalized, community-based approach to TES management. Primary steps for achieving this objective are to (a) designate geographic regions for development of plans, (b) locate DoD installations occurring within designated regions, (c) select a region of emphasis for developing a prototype assessment and management plan, (d) identify ecosystems and plant communities occurring within this region and determine their distribution on military installations, (e) determine listed and candidate animal and plant species and species at risk actually or potentially occurring on installations within this region, (f) evaluate habitat requirements and community associations for selected species, (g) assess potential impacts of military operations on plant communities and associated TES, and (h) develop a prototype assessment and management plan. This prototype plan will be used as a guide for developing assessment and management plans for other regions, and information for those plans is currently being collected.

Prototype TES management strategies will be developed that potentially apply to all installations within the region of emphasis. Habitat requirements and plant community associations will be determined for each species (based on the literature and coordination with species experts from other agencies, universities, and private organizations), and management strategies will be developed that apply collectively to species within a plant community. For

example, a community-based approach to TES management in cottonwood-willow riparian zones of the Southwest would recommend methods that protect and improve the system for all TES that depend on these corridors for survival (e.g., snag management, re-establishment of native plants, and buffer zone protection).

This approach will not ignore the legal and ecological requirements of individual species conservation. USFWS Recovery Plan guidelines for listed species and other management techniques for individual species will be important elements in the development of the final synthesis of management strategies. The importance of local as well as regional needs for TES will also be recognized because no general management practice will work in all cases, and management plans must be flexible enough to satisfy local requirements.[1] For example, some narrowly endemic plants, such as those occurring in the Florida Keys and Miami pine rocklands, will require specific local conservation plans.[2]

Management strategies should also consider what actions are ongoing or could be initiated with other Federal and State agencies that can contribute to species conservation. This could include contributions resulting from cooperative efforts with adjacent landowners, use of other-agency expertise, or pooling of other resources. While there are obvious limitations due to the inability to control areas outside DoD jurisdiction, this is an important consideration because management schemes can be hampered if critical factors are not included in the overall assessment. Areas adjacent to DoD installations may provide an extension of important habitats or ecological components critical for certain species, serve as corridors, and provide necessary buffers from harmful activities or disturbances.[3]

Several examples of collaboration with neighboring land managers were provided.[4] Avon Park Air Force Range hosts a land manager's working group that includes the Florida Division of Forestry (Arbuckle State Forest and overall wildfire control), Florida State parks (two park areas near Avon Park), Archbold Biological Station (an important private scientific research center with its own nature preserve), and TNC (several private reserves). An Army Reserve center at Petrine (southwest Miami), Florida, is collaborating with the Metropolitan Dade County Department of Environmental Resources Management and adjoining land managers, including a Department of Justice corrections center, a small Federal Aviation Administration facility, the MetroZoo, a county park, the U.S. Naval Observatory, and the U.S. Coast Guard. A botanical garden, Fairchild Tropical Garden, is providing vegetation monitoring expertise. Such collaborations have many benefits because

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1 Personal Communication, 1995, Marc Imlay, Headquarters, National Guard Bureau, Arlington, Va.

2 Personal Communication, 1995, David L. Martin, USFWS, Jacksonville, FL.

3 Personal Communication, 1995, Jim Serfis, U.S. Environmental Protection Agency, Washington, DC.

4 Personal communication, 1995, David L. Martin, USFWS, Jacksonville, FL.

managers from different agencies can often share resources (e.g., reciprocal assistance for prescribed burns).

Regionalization Schemes

There is currently a national emphasis on managing natural resources from an ecosystem or landscape perspective, because this approach provides a means of simultaneously managing for a variety of resources and enables more efficient and effective conservation of biological diversity. Furthermore, it has become widely recognized that environmental sustainability can only be achieved by taking a holistic approach to resource conservation (USFWS 1994b; Trame and Tazik 1995). Many State and Federal agencies are working to develop viable approaches to conserve and manage natural resources from these perspectives. A variety of regionalization schemes have been developed that partition the United States into regions for a variety of purposes, including natural resource management. These schemes are often used as tools to aid development of broad natural resource management programs. Many of these schemes were investigated to determine the most appropriate system, or combination of systems, to use for DoD TES programs. Primary considerations were physiography, major plant communities or ecosystems present, potential for supporting populations of the same species, and locations of military installations. Selected schemes are discussed below.

Ecoregions

Ecoregions are large ecosystems of regional extent that contain a number of smaller ecosystems. They are geographical zones that represent groups or associations of similarly functioning ecosystems (Bailey 1983). Two national regionalization systems that employ the ecoregion concept were developed for natural resource assessment in the United States. These systems are Bailey's (1983) *Ecoregions of the United States* and Omernik's (1987) *Ecoregions of the Conterminous United States*. The concept of ecoregions is based on the supposition that each region covers a homogenous area with respect to the characteristics that are used to define it. Although there is variation in the types of plant communities occurring within ecoregions, the within-region variation is assumed to be less than the between-region variation.

Bailey's (1976, 1980, 1983) original ecoregion system was a fourth-order hierarchy based mainly on bioclimatic features. Four ecological levels were used to delineate ecosystems, usually with single environmental characteristics defining each level. This original hierarchical scheme had 4 Domains, 12 Divisions, 31 Provinces, and 45 Sections. Vegetation served as the primary criterion for the delineation of regional boundaries. Each ecoregion was assigned a 4-digit number that reflected descriptive characteristics of the scheme, and area of sections averaged 130,000 km^2. This system was initially developed to define terrestrial ecosystems managed by the USFS. Bailey's original system was also used by the USFWS for the National Wetlands

Inventory (Dahl, Johnson, and Frayer 1991), National Gap Analysis Project (Davis et al. 1990), and as a Geographic Information Systems (GIS) overlay to assist in making biological assessments (Giudice and Ratti 1992).

Recently, Bailey et al. (1994) introduced *Ecoregions and Subregions of the United States* (Table 2), which is a modification of Bailey's (1983) original ecoregion scheme. The original ecoregion approach by Bailey was criticized (Gallant et al. 1989) because boundaries were based on only one characteristic (i.e., climate, potential natural vegetation, or land-surface form) at each hierarchical level. The purpose of the new framework is to use associations of ecological factors at different geographic scales to systematically classify and map the United States. The new scheme, The National Ecological Unit Hierarchy, consists of four different scales: Ecoregion, Subregion, Landscape, and Land unit. The Ecoregion is defined by Domains, Divisions, and Provinces, and the Subregion is defined by Sections and Subsections (Table 2). The latter two scales are defined in Bailey et al. (1994).

Omernik's (1987) ecoregion scheme, a third-order hierarchy, was developed to classify streams for more effective water-quality management. Omernik (1987) delineated 76 ecoregions of the 48 conterminous United States. Delineation was based on the interaction of several environmental characteristics, including land-surface form, potential natural vegetation, soils, and land use. This scheme has been widely tested and successfully validated for water quality assessment of streams and rivers. However, according to Gallant et al. (1989), this approach may not be suitable for some terrestrial assessments.

USFWS ecosystem approach

The USFWS recently introduced the *Ecosystem Approach to Fish and Wildlife Conservation* (USFWS 1994b), an ecological-regionalization scheme, as a means of assessing and conserving the nation's biological diversity. The scheme identifies Ecosystem Units for management purposes by grouping or breaking down U.S. Geological Survey (USGS) Watershed Units delineated from the USGS Hydrologic Unit Map. Ecosystem Units (i.e., watersheds) are defined by vegetation cover types, physiography, and optimum size. Units may be further subdivided when necessary (e.g., more intense activity in a certain area). Forty-one watershed units have been defined for the conterminous U.S. The USFWS divided the Southeast into 15 distinct Ecosystem Units based on watershed boundaries and is currently developing separate Ecosystem Unit Management Plans with accompanying goals and objectives.[1]

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[1] Personal Communication, 1995, David P. Flemming, USFWS, Atlanta, GA.

Table 2
Hierarchy for Bailey's *Ecoregions and Subregions of the United States* (Bailey et al. 1994)

Level	Name	Definition	Principal Map Unit Design Criteria	Examples of Descriptive Names
1	Domain	Subcontinental areas identified by broad climatic similarity.	Broad climatic zones or groups	Dry, Tropical
2	Division	Areas having definite vegetational affinities and falling within the same regional climate.	Regional climate types the level of Koppen (1931) and Trewartha (1968), vegetational affinities, and soil order	Warm Continental, Prairie, Temperate Steppe, Marine
3	Province	Subdivisions of a Division that correspond to broad vegetation regions, which conform to climatic subzones controlled primarily by continental weather patterns. They are also characterized by soil orders.	Dominant potential natural vegetation (Kuchler 1964). Highlands or mountains with complex vertical climate-vegetation-soil zonation.	Southeastern Mixed Forest, Prairie Parkland, Great Plains Steppe
4	Section	Units within provinces based on the composition of the climax vegetation type, generally corresponding to the potential natural vegetation types of Kuchler (1964). They are broad areas of similar geomorphic processes, stratigraphy, geologic origin, drainage networks, topography, and regional climate.	Geomorphic province, geologic age, stratigraphy, lithology; regional climatic data; soil order phase; potential natural vegetation; potential natural communities (PNC).	Mojave Desert, Nebraska Sand Hills, Black Hills, N. Rocky Mountains
5	Subsection	Smaller areas of Sections with similar surficial geology, lithology, geomorphic processes, soil groups, subregional climate, and potential natural communities.	Geomorphic processes, surficial geology, lithology; phases of soil orders; subregional climatic data; PNC (formation or series)	Plainfield Sand Dune, Tipton Till Plain, Granite Hills

Other regionalization schemes

The Land Resource Regions hierarchical regionalization scheme (Austin 1972; USDA 1981) was developed primarily for the management of agricultural lands, but it has limited utility for natural resource management (Gallant et al. 1989). The USGS hydrologic-unit framework (Cushman et al. 1980; USGS 1982) consists of 21 water-resource regions in the United States, including Alaska, Hawaii, and Puerto Rico. The National Water Assessment Project (U.S. Water Resources Council 1978) subdivided these regions into subregions and hydrologic units (water resource regions) describing drainage areas of rivers. Gallant et al. (1989) and Omernik and Griffith (1991) suggested that schemes based solely on hydrologic units are not appropriate for summarizing ecological data (Giudice and Ratti 1992).

A variety of other regionalization schemes have been developed and frequently used to regionalize the United States, but were not deemed appropriate for purposes of this approach. For example, physiographic regions reflect regional patterns of environmental resources for some areas of the United States, but have low utility for indicating spatial patterns in resource quality (Giudice and Ratti 1992).

Classification of TES regions

Bailey et al.'s (1994) ecoregion framework was selected to classify TES regions for management purposes because it has been used previously to define terrestrial ecosystems, and the broad regions recognized were considered most appropriate for addressing plant communities throughout their entire range. Although Bailey (1983) cautioned that ecoregion boundaries were transition zones of varying width, he suggested that similar habitats within ecoregions should exhibit similar biological responses to management and disturbance. Omernik (1987) confirmed this hypothesis for stream ecosystems. The selection of TES regions using the Ecoregion approach is discussed in Chapter 3.

It should be pointed out that the selection of Bailey's ecoregions for development of management handbooks does not represent a contradiction with other regionalization schemes and will not preclude the recognition of other approaches useful for ecosystem management. For example, watershed-based units delineated for the USFWS ecosystem approach (USFWS 1994b) will be recognized for assessing certain conditions, especially hydrologic patterns, within the broader regions of Bailey. In some cases, plant communities will even extend across more than one of Bailey's ecoregions, e.g., big cordgrass (*Spartina alterniflora*) communities that occur in intertidal zones of the Atlantic Coast and Gulf of Mexico.

Plant Community Classification Schemes

A number of different classification schemes can be used to delineate plant communities occurring in the southeastern United States. These include the Society of American Forester's cover types (Eyre 1980), the USFS cover types (USFS 1987), the USFWS wetland types (Cowardin et al. 1979), and Kuchler's (1964) potential vegetation types. In addition, individual States have developed their own classification schemes to characterize plant communities (e.g., Schafale and Weakley 1990; Smith and Craig 1990; Nelson 1986).

The recently published three-volume series *Biodiversity of the Southeastern United States* (Hackney, Adams, and Martin 1992; Martin, Boyce, and Echternacht 1993a,b) was chosen as the primary reference for classifying and describing plant communities in the southeastern U.S. Upland terrestrial communities, lowland terrestrial communities, and aquatic communities are each described in separate volumes. Terrestrial community volumes are based on a Kuchler's (1964) potential vegetation types and are divided into five parts: (a) the physical environment of the type(s), (b) actual plant communities within the type, (c) associated animal communities, (d) resource use and management effects (both historical and current), and (e) research and management needs (Martin, Boyce, and Echternacht 1993a,b). This scheme was chosen to classify communities on military installations because the literature synthesis is recent, communities are classified on a regional basis (and information on regional variation in vegetation, structure, and nomenclature is provided), the scale of classification appears to be at a level that is useful for natural resource managers, and communities occurring on installations are often described at a scale that is easily adapted to this classification. For example, Stout and Marion's (1993) chapter entitled "Pine Flatwoods and Xeric Pine Forests of the Southern (Lower) Coastal Plain" describes five lower Coastal Plain pine communities: pine flatwoods, rockland pinelands, longleaf pine-turkey oak sandhills, sand pine scrub, and scrubby flatwoods. An example plant community abstract for pine flatwoods is provided (Appendix A).[1] Synonyms used for this community on installations are provided (Table A1 of Appendix A).

Other secondary references being used for classification are "Vegetation of the Southeastern Coastal Plain" (Christensen 1988), *Ecosystems of Florida*, edited by Myers and Ewel (1990), and journal articles. Available information from State classification schemes and TNC's Southeastern Regional Ecological Community Classification (Allard 1990) is being utilized in the plant community descriptions.

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1 The information for the Pine Flatwoods community in Appendix A is in draft form. Information is still being added and updated, but is provided as a prototype example of future plant community management abstracts.

Prototype Study

The southeastern U.S. (TES SE Region; see Chapter 3) was selected for developing a prototype plan because this region contains a large number of installations, many of which have potential TES concerns. Also, extensive studies on selected species and their habitats have been conducted in this region by DoD and other State and Federal agencies (e.g, USFS, USFWS). A variety of sources will be investigated to identify TES and the distribution of major plant communities within Bailey et al.'s (1994) ecoregions of the southeastern U.S. (Table 3).

The general approach will be to (a) identify plant communities and associated TES occurring on installations in the Southeastern Region, (b) conduct extensive literature reviews on those TES to determine their occurrence within plant communities and ecosystems, (c) evaluate potential and existing management schemes for these plant communities, and (d) assess trade-offs in management schemes based on their benefit or detriment to TES occurring within these communities and ecosystems.

TES selected for study are those known to occur on at least one installation in the Southeast. Information on species occurrence on installations was provided by various sources, including Headquarters of each military service branch, military installations, State Natural Heritage Programs, and TNC. Information is currently being collected on ecology and management of these species from USFWS Recovery Plans, reports, peer-reviewed literature, experts familiar with the species, associated communities, and installations of concern.

Table 3
Bailey et al.'s (1994) Ecoregions in the Southeastern TES Region

TES Region	Bailey Ecoregion	Domain	Division	Province	Section
SE	230	Humid temperate	Subtropical	Southeastern mixed forest	
SE	231	Humid temperate	Subtropical	Southeastern mixed forest	
SE	231A	Humid temperate	Subtropical	Southeastern mixed forest	Southern Appalachian Piedmont
SE	231B	Humid temperate	Subtropical	Southeastern mixed forest	Coastal plains, middle
SE	231C	Humid temperate	Subtropical	Southeastern mixed forest	Southern Cumberland Plateau
SE	231D	Humid temperate	Subtropical	Southeastern mixed forest	Southern ridge and valley
SE	231E	Humid temperate	Subtropical	Southeastern mixed forest	Mid coastal plains, western
SE	231F	Humid temperate	Subtropical	Southeastern mixed forest	Eastern Gulf prairies and marshes
SE	231G	Humid temperate	Subtropical	Southeastern mixed forest	Arkansas valley
SE	232	Humid temperate	Subtropical	Outer coastal plain mixed forest	
SE	232A	Humid temperate	Subtropical	Outer coastal plain mixed forest	Middle Atlantic coastal plain
SE	232B	Humid temperate	Subtropical	Outer coastal plain mixed forest	Coastal plains and flatwoods, lower
SE	232C	Humid temperate	Subtropical	Outer coastal plain mixed forest	Atlantic coastal flatlands
SE	232D	Humid temperate	Subtropical	Outer coastal plain mixed forest	Florida coastal lowlands (western)
SE	232E	Humid temperate	Subtropical	Outer coastal plain mixed forest	Louisiana coast prairies and marshes
SE	232F	Humid temperate	Subtropical	Outer coastal plain mixed forest	Coastal plains and flatwoods, western Gulf
SE	232G	Humid temperate	Subtropical	Outer coastal plain mixed forest	Florida coastal lowlands (eastern)
SE	234	Humid temperate	Subtropical	Lower Mississippi riverine forest	
SE	234A	Humid temperate	Subtropical	Lower Mississippi riverine forest	Mississippi alluvial basin
SE	M230	Humid temperate	Subtropical regime mtns		
SE	M231	Humid temperate	Subtropical regime mtns	Ouachita mixed forest-meadow	
SE	M231A	Humid temperate	Subtropical regime mtns	Ouachita mixed forest-meadow	Ouachita Mtns
SE	400	Humid tropical			
SE	410	Humid tropical	Savannah		
SE	411	Humid tropical	Savannah	Everglades	
SE	411A	Humid tropical	Savannah	Everglades	Everglades

3 Project Status

The original proposal for this work unit was submitted to SERDP by WES in 1993. The work was to be shared by WES and CERL and, thus, would serve as a positive example of partnering among laboratories. Funding for the project was received in October 1993. A meeting of WES and CERL investigators was held at WES on 27 October 1993. The regional concept was discussed and FY94 tasks were identified. Several additional meetings were held in FY94 and FY95 to refine tasks.

Milestones

Milestones were originally established for FY93-95 but were later changed to show FY94-96 work due to the late arrival of funds. Milestones were also modified in FY94 to reflect the conversion to programmatic work units and reduction in funds of approximately 40 percent over the life of the project. Current milestones are shown in Table 4.

Numerous regionalization schemes were examined to determine the most appropriate regions for assessing TES on DoD lands. Ten TES regions (Figure 1; Table 5) were established for the conterminous United States, and two additional regions were established for Alaska and the Hawaiian Islands. The boundaries of these regions were defined by differences in the major vegetation types of Bailey et al.'s (1994) ecoregions. The USFWS watershed approach (USFWS 1994b) was also considered a viable approach because watershed boundaries in the Southeast generally fit within the ecoregions defined by Bailey et al. (1994). Because most of the plant communities occur in several watershed units, it was more appropriate to use ecoregions. The regionalization scheme based on Bailey et al.'s publication provided the initial degree of resolution for the delineation of TES regions; however, the scale was insufficient for identifying individual plant communities to adequate resolution for this work. Major plant communities of the Southeast were characterized by Christensen (1988), Allard (1990), Myers and Ewel (1990), and Stout and Marion (1993). The applicability of these vegetation schemes developed to delineate plant communities in the southeastern U.S. will be investigated (see Appendix A for a prototype plant community description). As with

Table 4
Milestones and Projected Completion Dates

Milestone	Date
Define geographic regions	3/94
Select species/habitats for evaluation	6/94
Conduct background survey on first set of species	9/94
Complete Concept Plan and Status Report	9/94
Complete Technical Report on Concept Plan and Status Report	8/95
Assess habitat requirements and complete draft species profiles for selected species	8/95
Assess potential impacts of military operations	9/95
Complete drafts of selected plant community abstracts	9/95
Identify existing habitat/community assessment strategies for TES management	8/96
Complete additional plant community abstracts and species profiles	9/96
Develop management strategies and techniques	4/97
Complete prototype regional handbook	9/97

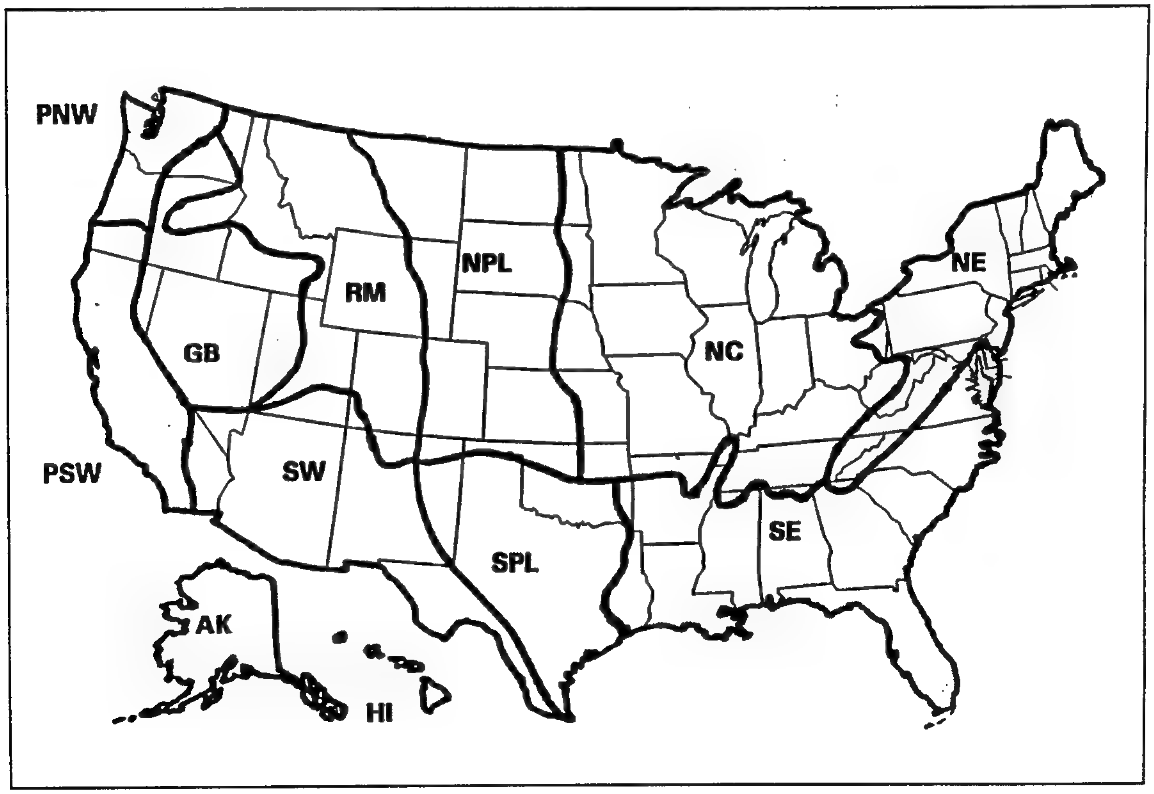

Figure 1. TES regions established for the United States

Table 5
Regions Established for Management of TES Species on Military Installations

TES Region	Acronym	States
Pacific Northwest	PNW	W. Washington, W. Oregon
Pacific Southwest	PSW	SW Oregon, majority of California
Great Basin	GB	Nevada, SE and North-central Oregon, SE Washington, S. Idaho, W. Utah
Rocky Mountains	RM	NE Washington, N. and C. Idaho, W. Montana, W. Wyoming, NE Utah, W. Colorado, North-central Arizona
Northern Plains	NPL	E. Montana, E. Wyoming, E. Colorado, W. and C. North Dakota and South Dakota, W. Nebraska, W. Kansas, NW Oklahoma, NE Arizona
Southwest	SW	SE California, Arizona, E., C., and S. New Mexico, SW Texas, S. Nevada
Southern Plains	SPL	S. Oklahoma, N., C., and S. Texas, E. New Mexico
North Central	NC	Minnesota, Michigan, Wisconsin, Iowa, Missouri, N. Arkansas, Illinois, Indiana, N., C., and S. Ohio, Kentucky, E. and C. Tennessee, E. West Virginia, E. portions of North Dakota and South Dakota, Nebraska, and Kansas
Southeast	SE	E. Texas, C. and S. Arkansas, Alabama, Mississippi, Louisiana, Georgia, Florida, South Carolina, E. and C. North Carolina, E. Virginia, E. Maryland, and Delaware
Northeast	NE	Maine, New Hampshire, Vermont, New York, Massachusetts, Connecticut, Rhode Island, Pennsylvania, N. Maryland, E. West Virginia, E. Tennessee, N. Georgia, W. North Carolina, E. Ohio, Western Virginia
Alaska	AK	Alaska
Hawaii	HI	Hawaii

most regionalization schemes, there is wide variation within regions (e.g., precipitation, soils, vegetation); thus, various subregions may be identified within each TES region (e.g., South Florida Everglades in Southeast TES region).

A database of United States TES was constructed in spreadsheet format. Data fields used in this database include common name, scientific name, region, State, or territory, USFWS status, and occurrence on military installations. A map of Army, Navy, Air Force, and Marine Corps installations in the Southeastern Region was constructed (Figure 2), and reference information on each of these installations is provided in Appendix B. These installations were assigned to one of Bailey's (1994) ecoregions to identify installations potentially having similar habitats and plant communities. The goal is to

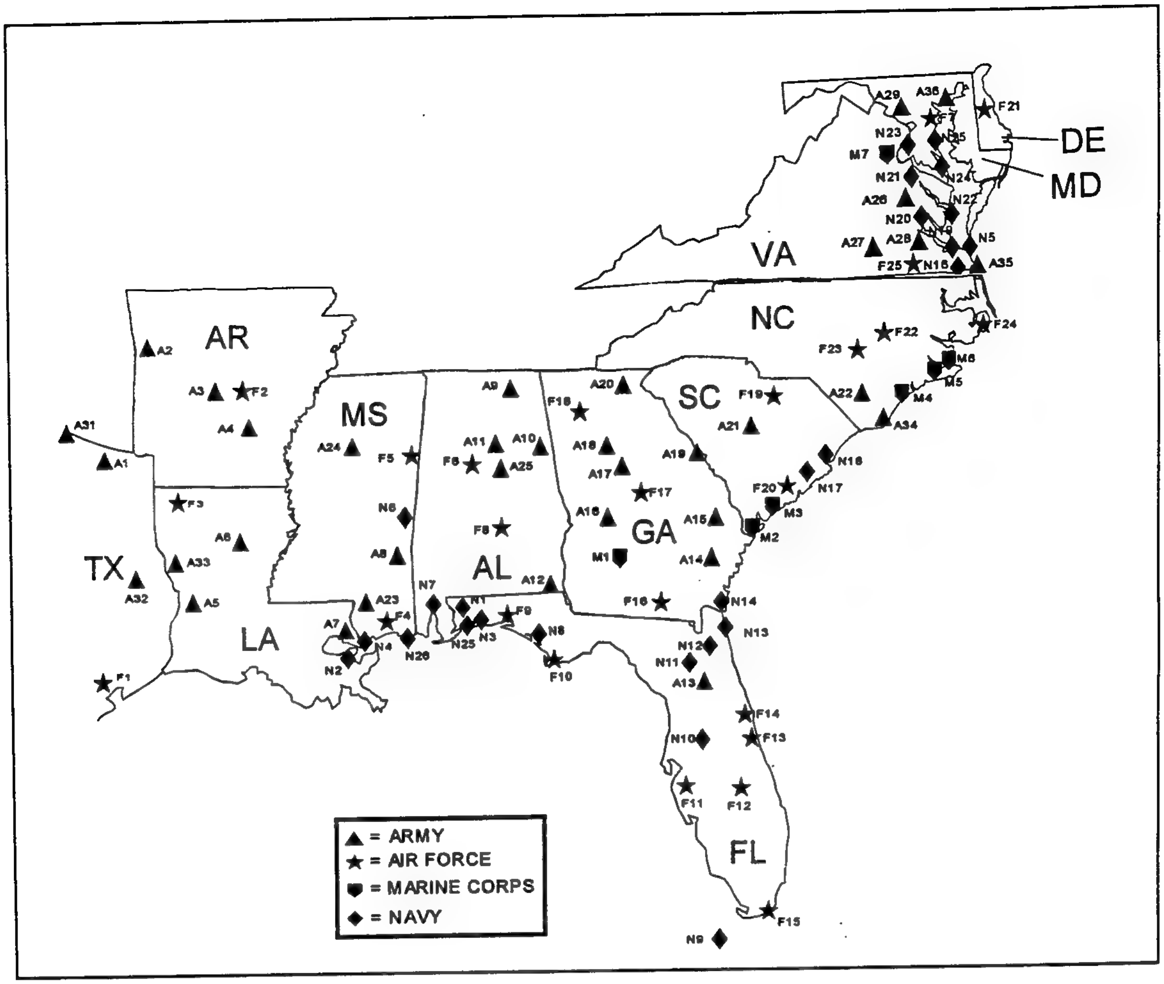

Figure 2. Military installations in the southeastern United States

identify installations that share the same TES and plant communities, and develop strategies that will provide consistency in TES habitat and plant community evaluation and management.

The Southeastern Region was selected as the region of emphasis for initial study because DoD, USFWS, and USFS currently are conducting work on several species in this region. Also, both CERL and WES have ongoing studies on Army, Air Force, Marine Corps, and DOE lands in the Southeast. Thus, information already exists for the conservation and management of several species and communities in this region. Information is also being compiled on plant communities and associated TES in the Southwestern and Southern Plains TES regions.

Current Tasks

An initial tabulation was made of all Federally listed and candidate species, and species at risk known to occur within designated regions. Approximately 100 plant and animal species occurring on installations in the Southeastern Region (Tables 6 and 7) were selected for initial evaluation. Many of these species occur on more than one installation, and a matrix showing which installations share the responsibility for the same TES plant species is provided (Appendix C). A background survey (literature reviews and contacts with species experts) is being conducted on these species, which includes examination of databases maintained by WES, CERL, TNC, State Natural Heritage Programs, and on individual installations. Other sources of information include USFWS Recovery Plans, TNC Element Stewardship Abstracts, literature reviews, the USDA publication *A Report on Some Rare, Threatened, or Endangered Forest-related Vascular Plants of the South* (Kral 1983), species status reports, USFWS Red Book species accounts, TESII database compilations (Golden, CO), regional experts, and military personnel.

For each plant community (e.g., Pine Flatwoods; Appendix A) occurring on a military installation within the region, a list of installations on which it occurs, a community description, a management prescription for that plant community and the surrounding ecosystem, information on community-level threats (general and military specific), and a list of plant and animal species of concern that occur in that community will be provided. This list will include Federally listed, candidate, and State rare plant species (and the States in which they are rare) known to occur in this community.

Plant communities have been tentatively identified for the Southeast, and Plant Community Abstracts are in preparation. Abstracts include information on classification, nomenclature, geographic range, significance of community type, environmental factors (e.g., topography, hydrology, soils, fire regime), physiognomy/structure, associated plant communities, successional relationships, biological composition, impacts to the community (general and military specific), indicators of community quality, and plant community management prescriptions (e.g., burning, hydrology management, erosion control, management of exotic species, timber management, wildlife management, and modification of military activities). The positive aspects of military activities on TES will also be addressed. Appendix A is an example of a TES Plant Community Abstract.

Species Profiles are also being developed for selected animal TES occurring in designated plant communities. These profiles include information on status, life-history and ecology, habitat requirements, habitat assessment techniques, impacts and causes of decline, and management recommendations. Information developed for the Species Profiles will provide input for sections of the Plant Community Abstracts. For example, the Pine Flatwoods Community Abstract will include appropriate biological and management information on the red-cockaded woodpecker, Bachman's sparrow, Florida black

Table 6
List of Threatened, Endangered, and Candidate Species and Species at Risk for Plants Known To Occur on at Least One Military Installation in the Southeastern United States

Common Name	Scientific Name	Status
	Woody Plants	
Anise tree, Yellow	*Ilicium parviflorum*	SAR
Buckthorn	*Bumelia thornei*	SAR
Butternut	*Juglans cinera*	SAR
Lead-plant, Georgia	*Amorpha georgiana* var. *georgiana*	SAR
Jointweed, Large-leaved	*Polygonella macrophylla*	SAR
Magnolia, Ashe's	*Magnolia ashei*	SAR
Maricao Cimarron	*Byrsonomia lucida*	SAR
Pixie-moss, Well's (sandhill)	*Pyxidanthera barbulata* var. *brevifolia*	SAR
Pondspice	*Litsea aestivalis*	SAR
Rhododendron, Chapman's	*Rhododendron chapmanii*	E
Spicebush, Bog	*Lindera subcoriacea*	SAR
Sumac, Michaux's	*Rhus michauxii*	E
White-wicky	*Kalmia cuneata*	SAR
Wireweed	*Polygonella basiramia*	E
	Forbs	
Amaranth, Seabeach	*Amaranthus pumilus*	T
Aster, Chapman's	*Aster chapmanii*	SAR
Aster, Coyote-thistle	*Aster eryngiifolius*	SAR
Aster, Cruise's Golden	*Chrysopsis gossypina cruiseana*	SAR
Aster, Godfrey's Golden	*Chrysopsis godfreyi*	SAR
Balduina, Purple	*Balduina atropurpurea*	SAR
Barbara's Buttons, Mohr's	*Marshallia mohrii*	T
Bog Buttons, Tiny	*Lachnocaulon digynum*	SAR
Bog-asphodel, Smooth	*Tofieldia glabra*	SAR
Bogmint, Carolina	*Macbridea caroliniana*	SAR
Boneset, Pine Barrens	*Eupatorium resinosum*	SAR
Butterwort, Chapman's	*Pinguicula planifolia*	SAR
Butterwort, Godfrey's	*Pinguicula ionantha*	T
		(Sheet 1 of 3)

Table 6 (Continued)

Common Name	Scientific Name	Status
Forbs (Continued)		
Chaffseed, American	*Schwalbea americana*	E
Coneflower, Bog	*Rudbeckia scabrifolia*	SAR
Coneflower, Smooth	*Echinacea laevigata*	E
Coneflower, Sunfacing	*Rudbeckia heliopsidis*	SAR
Coneflower, Yellow	*Rudbeckia nitida* var. *nitida*	SAR
Cowbane, Piedmont	*Oxypolis ternata*	SAR
Cowlily, West Florida	*Nuphar luteum ulvaceum*	E
Crownbeard, Chapman's	*Verbesina chapmanii*	SAR
Crownbeard, Variable-leaf	*Verbesina heterophylla*	SAR
Eulophia	*Pteroglossaspis ecristata*	SAR
Flax, West's	*Linum westii*	SAR
Goldenrod, Carolina	*Solidago pulchra*	SAR
Goldenrod, Spring-flowering	*Solidago verna*	SAR
Grass-of-parnassus, Carolina	*Parnassia caroliniana*	SAR
Groovebur, Incised	*Agrimonia incisa*	SAR
Hartwrightia	*Hartwrightia floridana*	SAR
Hoary-pea, Pineland	*Tephrosia mohrii*	SAR
Lady's Slipper, Southern	*Cypripedium kentuckiense*	SAR
Lily, Panhandle	*Lilium iridollae*	SAR
Lobelia, Boykin's	*Lobelia boykinii*	SAR
Loosestrife, Fraser	*Lysimachia fraseri*	SAR
Loosestrife, Rough-leaved	*Lysimachia asperulaefolia*	E
Lupine, Gulfcoast	*Lupinus westianus*	SAR
Meadowbeauty, Awned	*Rhexia aristosa*	SAR
Meadowbeauty, Panhandle	*Rhexia salicifolia*	SAR
Mercury, Blodgett's Wild	*Argythamnia blodgettii*	SAR
Milk-vetch, Sandhills	*Astragalus michauxii*	SAR
Milkvine, Alabama	*Matelea alabamensis*	SAR
Milkweed, Southern	*Asclepias viridula*	SAR
Monkey-face	*Platanthera integrilabia*	SAR
Morning-glory, Pickering's	*Stylisma pickeringii*	SAR
Pigeon Wings	*Clitoria fragrans*	T
		(Sheet 2 of 3)

Table 6 (Concluded)		
Common Name	**Scientific Name**	**Status**
Forbs (Continued)		
Pitcher Plant, White-topped	*Sarracenia leucophylla*	SAR
Pondweed	*Potamogeton confervoides*	SAR
Price's Potato-bean	*Apios priceana*	T
A Queen's Delight	*Stillingia sylvatica tenuis*	SAR
Rosinweed, Cumberland	*Silphium brachiatum*	SAR
Small Whorled Pogonia	*Isotria medeoloides*	T
Spurge, Porter's	*Chamaesyce porteriana* var. *scoparia*	SAR
Swamp Pink	*Helonias bullata*	T
Trillium, Relict	*Trillium reliquum*	E
Venus' Fly-trap	*Dionaea muscipula*	SAR
Water Milfoil, Piedmont	*Myriophyllum laxum*	SAR
Wild Indigo, Hairy	*Baptisia calcycosa* var. *villosa*	SAR
Yellow-eyed Grass, Drummond's	*Xyris drummondii*	SAR
Yellow-eyed Grass, Harper's	*Xyris scabrifolia*	SAR
Yellow-eyed Grass, Quillwort	*Xyris isoetifolia*	SAR
Yellow-eyed Grass, Tennessee	*Xyris tennesseensis*	E
Grasses, Rushes, and Sedges		
Beaked-rush, Decurrent	*Rhynchospora decurrens*	SAR
Beaked-rush, Hairy-peduncled	*Rhynchospora crinipes*	SAR
Bluestem, Scrub	*Schizachyrium niveum*	SAR
Dropseed, Pinebarrens	*Sporobolus* sp. 1	SAR
Grass, Cutthroat	*Panicum abscissum*	SAR
Grass, Curtis' Sand	*Calamovilfa curtissii*	SAR
Grass, Southern Three-awned	*Aristida simpliciflora*	SAR
Jointgrass, Piedmont	*Coelorachis tuberculosa*	SAR
Panic Grass, Hirst's	*Panicum hirstii*	SAR
Panic Grass, Naked-stemmed	*Panicum nudicaule*	SAR
Sedge, Baltzell's	*Carex baltzellii*	SAR
Sedge, Chapman's	*Carex chapmanii*	SAR
Sedge, Umbrella	*Cyperus grayoides*	SAR
Lichens		
Cladonia, Florida Perforate	*Cladonia perforata*	E
		(Sheet 3 of 3)

Table 7
List of Threatened, Endangered, and Candidate Species and Species at Risk for Animals (less fishes and invertebrates) Known To Occur on at Least One Military Installation in the Southeastern United States

Common Name	Scientific Name	Status
Mammals		
Bat, Indiana	*Myotis sodalis*	E
Bat, Gray	*Myotis grisescens*	E
Bat, Rafinesque's Big-eared	*Plecotus rafinesquii*	SAR
Bear, Louisiana Black	*Ursus americanus luteolus*	PT
Bear, Florida Black	*Ursus americanus floridanus*	SAR
Myotis, Southeastern	*Myotis austroriparius*	SAR
Squirrel, Sherman's Fox	*Sciurus niger shermani*	SAR
Wolf, Red	*Canis rufus*	E
Birds		
Bunting, Eastern Painted	*Passerina ciris ciris*	SAR
Eagle, Bald	*Haliaeetus leucocephalus*	T
Falcon, Peregrine	*Falco peregrinus anatum*	E
Jay, Florida Scrub	*Aphelocoma coerulescens coerulescens*	T
Kestrel, Southeastern American	*Falco sparverius paulus*	SAR
Pelican, Brown	*Pelecanus occidentalis*	E
Plover, Piping	*Charadrius melodus*	E
Plover, Southeastern Snowy	*Charadrius alexandrinus tenuirostris*	SAR
Rail, Black	*Laterallus jamaicensis*	SAR
Shrike, Loggerhead	*Lanius ludovicianus migrans*	SAR
Sparrow, Henslow's	*Ammodramus henslowii*	SAR
Sparrow, Bachman's	*Aimophila aestivalis*	SAR
Stork, Wood	*Mycteria americana*	E
Tern, Least	*Sterna antillarum*	E
Warbler, Cerulean	*Dendroica cerulea*	SAR
Woodpecker, Red-cockaded	*Picoides borealis*	E
Wren, Appalachian Bewick's	*Thryomanes bewickii altus*	SAR

(Continued)

Table 7 (Concluded)		
Common Name	**Scientific Name**	**Status**
	Reptiles	
Alligator, American	*Alligator mississippiensis*	T
Massasauga, Eastern	*Sistrurus catenatus catenatus*	
Snake, Black Pine	*Pituophis melanoleucus lodingi*	SAR
Snake, Florida Pine	*Pituophis melanoleucus mugitus*	SAR
Snake, Northern Pine	*Pituophis melanoleucus melanoleucus*	SAR
Snake, Southern Hognose	*Heterodon simus*	SAR
Snake, Eastern Indigo	*Drymarchon corais couperi*	T
Snake, Gulf Salt Marsh	*Nerodia clarki*	SAR
Terrapin, Northern Diamondback	*Malaclemys terrapin terrapin*	SAR
Tortoise, Gopher (western population)	*Gopherus polyphemus*	T
Tortoise, Gopher (eastern population)	*Gopherus polyphemus*	SAR
Turtle, Alabama Red-bellied	*Pseudemys alabamensis*	E
Turtle, Alligator Snapping	*Macroclemys temmincki*	SAR
Turtle, Yellow-blotched Map	*Graptemys flavimaculata*	T
Turtle, Barbour's Map	*Graptemys barbouri*	SAR
	Amphibians	
Frog, Dusky Gopher	*Rana areolata sevosa*	C
Frog, Florida Gopher	*Rana areolata aesopus*	SAR
Frog, Carolina Gopher	*Rana areolata capito*	SAR
Hellbender	*Cryptobranchus alleganiensis*	SAR
Salamander, Flatwoods	*Ambystoma cingulatum*	C
	Insects	
Beetle, American Burying	*Nicrophorus americanus*	E

bear, eastern indigo snake, flatwoods salamander, Florida pine snake, and gopher frog.

Management plans, including any existing USFWS Recovery Plans, for TES occurring in the same plant communities will be compared and used to develop community-based management strategies. Potential for positive and negative effects of management on associated plant and animal species will be

evaluated. Management strategies for plant communities will reference the species profiles so that detailed information on the effects of these strategies on individual animal species can be obtained. In some cases, installations have completed rare species surveys that evaluate management at the community or ecosystem level. Existing reports from installations have been requested and are being used to assist the development of regional management strategies that apply to multiple species groups, communities, or ecosystems.

A large computer-based bibliographic database of TES literature is being compiled using the Pro-Cite software program (Personal Bibliographic Software, Inc., Ann Arbor, MI). This program allows the user to quickly search a large number of citations by author, title, literature source, and abstract. The database will be made available to DoD natural resources personnel when complete; it presently consists of approximately 1,700 references.

Several presentations were made on the study in FY95. These included presentations to the National Military Fish and Wildlife Association, 28-31 March 1995, in Minneapolis, MN; Strategic Environmental Research and Development Symposium, 12-14 April 1995, in Washington, DC; and the DoD National Conservation/Legacy Workshop, 5-9 June 1995, in Tacoma, WA. Additionally, the status of the work unit was presented at the SERDP Review, 15-17 May 1995, Fort Belvoir, VA, and TES User's Group Meeting, 18-19 May 1995, Washington, DC. Results of this meeting will be published in Tazik et al. (1995). A poster entitled "A Community Approach to Managing Threatened and Endangered Species on DoD Military Installations" was displayed at The Wildlife Society Annual Conference on 15 September 1995, in Portland, OR. A paper on the work unit was presentated at the DoD Forestry Workshop on 2 November 1995, in Portland, ME.

Current work has included several visits to military installations to obtain site-specific information on TES communities and to assess the potential impacts of military activities. Installations visited to date are Fort Polk, LA (plus adjacent Forest Service lands that are used for training under an Intensive Use Permit), Fort Jackson, SC, Fort Bragg, NC, Fort Benning, GA, and Fort Stewart, GA.

Future Work

FY95 work will consist of an investigation of the habitat and life history requirements for plant and animal species of concern within the Southeastern Region. The potential impacts of military operations will be examined and evaluated for positive and negative effects on these species and their associated plant communities. Special attention will be given to the landscape-level implications of military activities. For example, an assessment will be made of whether military activities are localized and directly impact individual TES, or whether impacts are felt across the landscape due to major changes in

ecological processes (e.g., hydrology, fire). A list of typical military activities that could potentially impact plant communities in the Southeast region has been constructed (Table 8). Preferred management strategies are those that will allow the military to continue their operation in a manner that has the least impact on TES and other sensitive species.

Table 8
List of Military Activities That Can Potentially Impact Plant Communities on Military Installations in the Southeastern United States

Activity	Description
Training on Foot	In file on established route; in file, line, or column moving cross-country; escape and evasion training
Use of Tracked Tactical Land Vehicle	In file on established route or moving cross-country; in column moving cross-country; crossing stream; tactical maneuver training
Use of Wheeled Tactical Land Vehicle	In file on established route or moving cross-country; in line or column moving cross-country; crossing stream; tactical maneuver training; transport of POL (petroleum, oil, and lubricants) or supplies cross-country
Military Watercraft	In coastal or inland waters
Airborne Operations	Air drop; firing airborne small arms, or medium and heavy weaponry; hover aircraft
Munitions	Firing small arms, or medium and heavy weaponry; firing missiles and rockets; use of incendiary devices
Potential Pollution	Use of smoke products, gases
Earthmoving Activities	Construction of obstacles, fortifications, or emplacements; engineer heavy equipment operations
Miscellaneous Activities	Firefighting, camouflage, bivouacking, bridge-building, assembly/staging activities

The development of management guidelines for the Southeastern Region will be initiated in FY95 and completed in FY97. Management guidelines will apply collectively to species with similar habitat requirements. The final product will be a prototype regional TES management handbook for one region (Southeast) that then can be modified and applied conceptually to other regions. Development of the handbook will require extensive coordination with biologists, land managers, and other natural resource personnel from military installations and other Federal agency offices throughout the Southeast. Activities will also be coordinated with appropriate State, TNC, and other conservation organization personnel. Work unit investigators will continue to visit selected installations to obtain site-specific information on plant communities and their associated species. The status of the project will be presented and discussed at the DoD TES Southeast Regional Workshop tentatively scheduled for third quarter, FY96.

Application

The project is designed to provide installation natural resources personnel with information to use in development of both short-term and long-term TES management plans. The ecosystem management prescriptions being developed are intended for use by all installations within the region of interest. Specific applications include preparation of biological assessments, management plans, and habitat/community management and monitoring strategies. Information provided in plant community abstracts and species profiles will be especially useful for preparing installation Endangered Species Management Plans (ESMP). ESMPs require details on species characterization, distribution, habitat requirements, life history and ecology, conservation measures, management prescriptions, and monitoring (Science Applications International Corporation 1995). Documents prepared for this work unit will include information that can be directly inserted in sections of ESMPs at installations in the Southeast. The application of specific work unit products will be reviewed annually at TES R&D User Group meetings.

Results of the study should also have applicability to other Federal and State agencies and conservation organizations. An additional goal of the project is to coordinate data and information bases among other agency personnel to extend technology transfer to as wide a user audience as possible. Information on the study has been provided to 10 Federal agencies and several State agencies and conservation organizations. Plans are being made to discuss the study and its application at regional interagency TES workshops in FY96 and FY97. Objectives of these workshops are to (a) identify existing ecological information, technologies, and methodologies that can be used to manage TES more effectively, (b) help focus Army inventory, monitoring, and research efforts on critical information needs and technology gaps, and (c) identify opportunities for future interagency coordination and cooperation (Tazik et al. 1995).

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Appendix A
Example Plant Community Abstract: Pine Flatwoods

Pine Flatwoods

Nomenclature

System. Terrestrial or Palustrine (Allard 1990).

Physiognomic type. Terrestrial Woodland/Savannas and Palustrine Woodland/Savannas (Allard 1990).

Classification system

This community is synonymous with the "flatwoods" community described by Stout and Marion (1993), the "mesic pine communities," including flatwoods and savannas, of Christensen (1988), and the "flatwoods" of Abrahamson and Hartnett (1990). The following communities listed in the Southeastern United States Ecological Community Classification (Allard 1990) are included in this community description: Atlantic Coastal Plain mesic longleaf pine forest, slash pine flatwoods, wet longleaf pine flatwoods, wet longleaf pine-slash pine flatwoods, Atlantic Coastal Plain wet longleaf pine savanna, Atlantic Coastal Plain wet-mesic longleaf pine savanna, East Gulf Coastal Plain longleaf pine savanna, and West Gulf Coastal Plain longleaf pine savanna.

Several pine flatwoods communities are described under a variety of names in State classification systems. In Louisiana, pine flatwoods and pine savannas are types of pine flatwoods communities (Smith 1988). Wharton's (1978) mesic pine lowland forest and longleaf pine upland forest in Georgia are types of pine flatwoods (Stout and Marion 1993). In Mississippi, coastal flatwood forests, wet flatwood forests, wet pine savannas, and pine savannas are types of pine flatwoods (Allard 1990). Nelson's (1986) pine savannas, pine flatwoods, pine-saw palmetto flatwoods, and upland pine-wiregrass

woodlands in South Carolina are all types of pine flatwoods communities. In North Carolina's State classification (Schafale and Weakley 1990), wet pine flatwoods, pine savannas, and mesic pine flatwoods are all types of pine flatwoods, as are mesic flatwoods and wet flatwoods in Florida (Florida Natural Areas Inventory (FNAI) and Florida Department of Natural Resources (FDNR) 1990). In Texas, the longleaf pine-beakrush series is a pine flatwoods community (Allard 1990). A list of names used to label this community on military installations is provided in Table A1.

Significance of community type

Flatwoods dominated by longleaf pine (*Pinus palustris*) are part of the larger longleaf pine-wiregrass (*Aristida stricta*) ecosystem that was once dominant throughout the coastal plain. The distribution of this ecosystem has been reduced by approximately 85 percent (or by 99.9 percent if old growth examples are included; Noss 1988). At the time of European settlement, longleaf pine communities covered at least 24 to 28 million ha; today these communities cover less than 4 million ha, and most of this is second growth and degraded (Noss 1988).

Communities within the wiregrass ecosystem (these generally have a canopy of longleaf pine or slash pine (*P. elliottii*) are extremely diverse floristically, and contain several rare and endemic plant taxa, making this one of the most important natural systems in the southeastern United States (Hardin and White 1989). Hardin and White (1989) listed 191 rare plant taxa as occurring in the wiregrass ecosystem; seven of these taxa have been proposed or listed as Federally endangered, and 61 are listed as threatened or endangered in three States. In addition, they estimated that the wiregrass ecosystem supports 66 rare, locally endemic plant taxa, including 33 from Florida, 2 from North Carolina, 14 from North and South Carolina, 5 from Florida and Georgia, and 5 from Alabama and Florida (Hardin and White 1989).

This ecosystem also supports a number of threatened, endangered, and candidate animal species and species at risk, including the endangered red-cockaded woodpecker (*Picoides borealis*). According to Krusac and Dabney (1994), there are 53 animal species (17 mammals, 7 birds, 13 reptiles, 6 amphibians, 7 insects, 1 arachnid) that co-occur with red-cockaded woodpeckers for which there are viability concerns because of fire suppression, habitat degradation, and habitat fragmentation.

Range

Bailey's ecoregion. Province 232-Outer Coastal Plain Mixed Forest. Section 232B-Coastal Plains and Flatwoods, Lower; Section 232C-Atlantic Coastal Flatlands; Section 232D-Florida Coastal Lowlands (Western);

Table A1
Occurrence of Flatwoods on Military Installations in the Southeastern United States

State	Branch	Installation	Name in Document	Reference
FL	Air Force	Eglin Air Force Base (AFB)	Mesic Flatwoods, Wet Flatwoods, Wet Prairies	Florida Natural Areas Inventory (FNAI) (1994b)
		Hurlburt Field sub: Eglin AFB	Wet Pine Flatwoods, Pine Flatwoods	Labat-Anderson, Inc. (1994)
		Tyndall AFB	Mesic Flatwoods, Wet Flatwoods	FNAI (1994a)
	Army	Camp Blanding	Longleaf Pine Flatwoods, Slash Pine Flatwoods	Personal Communication in 1994 between Mary G. Harper and Bob Brozka, who sent a list of rare species occurring on Camp Blanding and their associated communities.
	Navy	Naval Air Station (NAS) Cecil Field	Pine Flatwoods	Anon. (1988a), Environmental Services and Permitting, Inc. (1990)
		NAS Jacksonville	Pine Flatwoods	Anon. (1988b), Environmental Services and Permitting, Inc. (1990)
		McCoy Annex of the Naval Training Center Orlando	Mesic Flatwoods	FNAI (1992)
		NAS Pensacola and Outlying Field, Bronson	Pine Flatwoods, Wet Prairie, Low Wiregrass Savanna	Anon. (1988c), FNAI (1988)
		NAS Whiting Field	Flatwoods, Savannas	Anon. (1991)
GA	Air Force	Moody AFB	Pine Flatwoods	The Nature Conservancy (TNC) (1994)
	Army	Fort Benning	Pine Flatwoods	Gulf Engineers and Consultants and Geo-Marine, Inc. (1994)
		Fort Stewart	Atlantic Coastal Plain Mesic Longleaf Pine Forest, Slash Pine Flatwoods, Wet Longleaf Pine Flatwoods, Pine Savanna	TNC (1995)
	Marine Corps	Marine Corps Logistics Base (MCLB) Albany[1]	Name Not Provided	Georgia Department of Natural Resources (DNR) (1994)

(Continued)

[1] Indicates possible occurrence of Pine Flatwoods community.

Table A1 (Concluded)

State	Branch	Installation	Name in Document	Reference
LA	Army	Camp Villerie	Longleaf Pine Flatwoods Savanna	TNC (1993)
		Fort Polk	Flatwoods, Savannas	Personal Communication between Rhonda Stewart and Mary Harper in 1995.
MS	Army	Camp Shelby	Longleaf Pine Savanna	Managed Area Basic Records for Camp Shelby sent to Mary G. Harper from Ronald Weiland at the Mississippi Department of Wildlife, Fisheries and Parks, Jackson, MS, in 1994.
NC	Army	Camp MacKall and Fort Bragg	Mesic Pine Flatwoods, Wet Pine Flatwoods	Russo et al. (1993)
		Military Ocean Terminal (MOT) Sunny Point	Pine Savanna, Wet Pine Flatwoods	Lists of rare species and natural communities known to occur on the Sunnypoint Military Ocean Terminal, North Carolina, sent to Mary G. Harper from Michael P. Schafale at the North Carolina State Natural Heritage Program in 1994.
	Marine Corps	Marine Corps Air Station (MCAS) Cherry Point	Wet Pine Flatwoods	Leblond, Fussell, and Braswell (1994c)
		Marine Corps Base (MCB) Camp Lejuene	Mesic Flatwoods, Pine Savanna, Wet Pine Flatwoods	Leblond, Fussell, and Braswell (1994a), (1994b)
SC	Army	Fort Jackson	Mesic Pine Flatwoods	List of plant communities known to occur on Fort Jackson, SC, given to Mary G. Harper from Bert Pittman, South Carolina State Natural Heritage Program in 1995.
	Navy	Naval Weapons Station (NWS) Charleston[1]	Sandy or Moist Longleaf Pine Savanna	Anon. (1989)

Section 232F-Coastal Plains and Flatwoods, Western Gulf; 232G-Florida Coastal Lowlands (Eastern).

Jurisdictional range. AL, FL, GA, LA, MS, NC, SC, VA.

Current distribution. Southeastern coastal plain from Southeast Virginia south to Florida and west to Texas (Stout and Marion 1993).

Distribution on military installations. The occurrence of pine flatwoods on military installations in the southeastern U.S. is noted in Table A1. The following installations provided information that demonstrated they probably do not support pine flatwoods: Fort McClellan, Anniston Army Depot, Fort Rucker and Redstone Arsenal, AL; Fort Gordon in Georgia; Barksdale AFB and Louisiana Army Ammunition Plant, LA; Camp McCain, MS; Dare Bombing Range, NC. Information from Keesler AFB and Meridian AFB, MS, was provided, but there was not enough detail to determine whether this community occurs on them.

Environmental factors

Topographic position. This community occurs on extensive flats or terraces; it has low, flat topography (Stout and Marion 1993).

Hydrology. The community occurs on poorly drained soils. It may be saturated or exhibit standing water during the wet season, but may also dry out during the summer (Christensen 1988).

Fire regime. Frequent, low-intensity surface fires generally characterize the fire regime. Historical evidence suggests that a fire frequency of 1 to 3 years is necessary to maintain this community (Ware, Frost, and Doerr 1993). The chances that a severe, crown-killing fire will occur increase as the fire frequency decreases (Christensen 1988).

Soil. This community occurs on sandy soils that are poorly drained, acidic, and low in nutrients (Abrahamson and Hartnett 1990). Moisture level and clay content of the soil may vary across the range of this community.

Physiognomy/structure

Pine flatwoods (sensu Stout and Marion 1993) typically exhibit an emergent tree layer of pines with limbless lower trunks and a ground layer of low vegetation. However, physiognomy varies markedly with fire regime and moisture. For this reason, some authors (e.g., Christensen 1988) have subdivided pine flatwoods into two communities, flatwoods and savannas. In this case, "savannas" generally refer to communities that have not experienced fire suppression and have a sparse canopy of pines and a diverse groundcover, while "flatwoods" may refer to fire-suppressed communities that exhibit a

well-developed woody understory and a sparse groundcover (Christensen 1988).

Commonly associated plant communities

Wet prairies, marshes, upland sandhills, pine woods, dry prairies, sand pine scrub, scrubby flatwoods, xeric sandhills, and pocosins often occur adjacent to pine flatwoods (Abrahamson and Hartnett 1990; Christensen 1988). Smaller, often isolated examples of communities that may occur as inclusions in pine flatwoods are cypress dome and swamp forests, pond cypress pond forests, small depression pocosins, pitcher plant bogs, and Coastal Plain small depression pond complexes (Martin 1992a-e).

Successional relationships

Typical pine flatwoods may succeed to southern mixed hardwoods in the absence of fire, but successional rates and final composition of the vegetation may vary according to site conditions (Christensen 1988). Wetter slash pine and pond pine phases of pine flatwoods may succeed into bayheads (Stout and Marion 1993).

Biological composition

Dominant or characteristic plant species. Longleaf pine, slash pine, and pond pine (*P. serotina*) usually dominate the canopy in pure stands or in various combinations. Common understory species are gallberry (*Ilex glabra*), shiny blueberry (*Vaccinium myrsinites*), fetterbush (*Lyonia lucida*), dwarf live oak (*Quercus minima*), runner oak (*Q. pumila*), sand live oak (*Q. geminata*), hairy laurel (*Kalmia hirsuta*), and southern bayberry (*Myrica cerifera*). Saw palmetto (*Serenoa repens*) may also be a dominant understory component within its range. Common grasses are wiregrass or bluestems (*Andropogon* spp.); common forbs are milkweeds (*Asclepias* spp.), pinebarren aster (*Aster reticulatus*), vanillaleaf (*Carphephorus odoratissimus*), gayfeather (*Liatris* spp.), queens delight (*Stillingia sylvatica*), baptisia (*Baptisia* spp.), milkpea (*Galactia* spp.), yellow colicroot (*Aletris lutea*), deathcamas (*Zigadenus* spp.), polygala (*Polygala* spp.), and yellow-eyed grasses (*Xyris* spp.) (Stout and Marion 1993).

Variation in structure and composition. The composition and structure of pine flatwoods vary with geographic location, soil conditions, climate, and fire frequency. Historically, longleaf pine dominated more upland sites, while slash pine and pond pine increased in dominance with increasing hydroperiod and decreasing fire frequency. Outside of the natural range of slash pine, west of central Louisiana, and south of Georgetown County, South Carolina, longleaf pine occurred as a single dominant. Wiregrass was characteristic in

pine flatwoods east of Mississippi, but bluestems were characteristic in pine flatwoods to the west (Stout and Marion 1993).

Five distinct understory phases in pine flatwoods have been recognized. These are (a) wiregrass flatwoods, (b) cutthroat grass (*Panicum abscissum*) flatwoods, (c) palmetto flatwoods, (d) gallberry flatwoods, and (e) fern-south Florida slash pine (*Woodwardia virginica* and *Osmunda cinnamomea*/*P. elliottii* var. *densa*) (Stout and Marion 1993).

TES. Pine flatwoods support several Federally listed threatened and endangered species (TES), candidate species, species at risk, and many State-listed rare species. Lists of TES known to occur in pine flatwoods on military installations are provided (Tables A2, A3, and A4). In addition, Federally listed threatened and endangered plant species, candidate plant species, and plant species at risk that could potentially occur in this community are listed (Table A5). Information on known occurrence of species on installations was provided through installation reports and State heritage program databases.

Impacts to community (both general and military specific):

Land-use conversion. This includes conversion to agriculture, silviculture, and residential and commercial development. Land-use conversion fragments the landscape and eliminates habitat for sensitive species. Fragmentation in combination with incompatible land uses can also cause problems with management. For example, if communities requiring fire management are within city limits or are surrounded by housing, prescribed burning may not be feasible because of smoke management problems.[1] In many cases, fragmentation and habitat elimination reduce population sizes and bring species closer to extinction.

Fire suppression. Longleaf pine is one of the most fire adapted of all plants, being the only tree in the Southeast region with seedlings able to survive fire (Noss 1988). Longleaf pine and wiregrass, characteristic of this community east of eastern Mississippi,[2] are both fire-adapted and pyrogenic, containing volatile oils and resins in their needles and blades (Noss 1988), which contribute to the spread of fire. Fire suppresses hardwood and shrub invasion, provides areas of bare mineral soil necessary for regeneration of longleaf pine and other species (Noss 1988; Platt, Evans, and Davis 1988), causes turnover of litter, humus, and nutrients (Abrahamson and Hartnett 1990), and removes grass and sedge foliage, which shades smaller, herbaceous grasses and forbs that grow between the clumps (Walker and Peet 1983). Removal of competing hardwoods and shrubs and release of nutrients

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1 Personal Communication, 12 May 1995, A. Weakley, Southeast Regional Ecologist, Southeast Regional Office, The Nature Conservancy.

2 Longleaf-bluestem once dominated a large area of the Atlantic Coastal Plain, but this community has been degraded much more than longleaf-wiregrass and is now virtually extinct (Frost, Walker, and Peet 1986).

Table A2
Federally Listed Threatened, Endangered, and Candidate Plant Species and Species at Risk Occurring in This Community on Installations in the Southeast Region (See legend for information on status and rankings)

Common Name	Scientific Name	Installation	Federal Status	Global Rank	State Rank	State Status
Woody Plants						
Anise Tree, Yellow	*Illicium parviflorum*	NAS Jacksonville, FL	SAR	G1G2	FL: S1	FL: LT
Lead Plant, Georgia	*Amorpha georgiana* var. *georgiana*	Camp MacKall and Fort Bragg, NC	SAR	G2T2	NC: S1	NC: C
Rhododendron, Chapman's	*Rhododendron chapmanii*	Camp Blanding, FL	E	G1G2	FL: S1, S2	FL: LE
Forbs						
Bog-asphodel, Smooth	*Tofieldia glabra*	Camp MacKall and Fort Bragg, NC MCB Camp Lejeune, NC	SAR	G3	NC: S3	NC: C
Bog Buttons, Tiny	*Lachnocaulon digynum*	NAS Whiting Field, FL	SAR	G3	FL: S2	FL: Not Listed

(Sheet 1 of 3)

Legend: Federal Rankings: E = Endangered; T = Threatened; C = Candidate Species (former (C1 species); SAR = Species at Risk (former C2/C3 species); NL = Not Listed.

Global Rankings: G1 = Critically imperiled globally because of extreme rarity (very few individuals or acres) or because of some factor(s) making it especially vulnerable to extinction. G2 = Imperiled globally because of rarity or because of some factor(s) making it especially vulnerable to extinction. G3 = Either vary rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range. G4 = Apparently secure globally though possibly rare in some parts of the range, especially at the periphery. G5 = Demonstrably secure globally though possibly rare in some parts of the range, especially at the periphery. T = Taxonomic subdivision; rank applies to a subspecies or variety.

State Rankings: S1 = Critically imperiled in State because of extreme rarity (very few individuals or acres) or because of some factors making it especially vulnerable to extinction. S2 = Imperiled in State because of rarity or because of some factor(s) making it especially vulnerable to extinction. S3 = Rare or uncommon within the State. S4 = Apparently secure within the State. S5 = Demonstrably secure within the State.

State Statuses: C = Candidate; indicates rarity and the need for population monitoring and conservation action (NC); E = State-listed endangered (GA, NC); LE = State-listed endangered (FL, VA); LS = Listed as a species of special concern (FL); LT = State-listed threatened (FL, VA); PE = Proposed endangered—proposed for State listing (NC, VA); PT = Proposed threatened—proposed for State listing as threatened (NC, VA); R = Rare (GA); SC = Special concern, protected by State law (NC, VA), of concern in the State (SC); SP = State protected (AL); SR = Significantly rare—indicates rarity and need for population monitoring and conservation action (NC); T = State-listed threatened (GA, NC); U = Unusual (GA); V = Vulnerable (NC); W or WL = Watch list—Any other species believed to be rare and of conservation concern in the State, but not warranting active monitoring at this time (NC).

Mississippi and Louisiana do not designate State statuses for their rare species.

Table A2 (Continued)

Common Name	Scientific Name	Installation	Federal Status	Global Rank	State Rank	State Status
Forbs (Continued)						
Butterwort, Chapman's	*Pinguicula planifolia*	Eglin AFB, FL Hulburt Field sub: Eglin AFB NAS Pensacola and Outlying Field, Bronson, FL Tyndall AFB, FL Whiting Field, FL	SAR	G3	FL: S2	FL: LE
Chaffseed, American	*Schwalbea americana*	Camp MacKall and Fort Bragg, NC	E	G2	NC: S1	NC: E
Coneflower, Yellow	*Rudbeckia nitida* var. *nitida*	Fort Stewart, GA	SAR	G3T1, T3	GA: S3	GA: Not Listed
Cowbane, Piedmont	*Oxypolis ternata*	MCB Camp Lejeune, NC	SAR	G3?	NC: S3	NC: C
Crownbeard, Chapman's	*Verbesina chapmanii*	Tyndall AFB, FL	SAR	G2G3	FL: S2 S3	FL: LT
Flax, West's	*Linum westii*	Eglin AFB, FL	SAR	G2	FL: S2	FL: LT
Goldenrod, Carolina	*Solidago pulchra*	MCAS Cherry Point, NC MCB Camp Lejeune, NC	SAR	G3	NC: S3	NC: E
Goldenrod, Spring Flowering	*Solidago verna*	Camp MacKall and Fort Bragg, NC MCAS Cherry Point, NC	SAR	G3	NC: S3	NC: E
Groovebur, Incised	*Agrimonia incisa*	MCLB Albany, GA	SAR	G3	GA: S2	GA: Not listed
Loosestrife, Rough-leaved	*Lysimachia asperulaefolia*	Camp MacKall and Fort Bragg, NC	E	G3	NC: S3	NC: E
Meadowbeauty, Awned	*Rhexia aristosa*	MCB Camp Lejeune, NC	SAR	G3	NC: S3	NC: T
Milkweed, Southern	*Asclepias viridula*	Eglin AFB, FL	C	G2	FL: S2	FL: LT

(Sheet 2 of 3)

Table A2 (Concluded)

Common Name	Scientific Name	Installation	Federal Status	Global Rank	State Rank	State Status
Forbs (Continued)						
Pitcher Plant, White-topped	*Sarracenia leucophylla*	Eglin AFB, FL Hulburt Field sub: Eglin AFB, FL NAS, Pensacola, FL	SAR	G3	FL: S3	FL: LE
Venus' Flytrap	*Dionaea muscipula*	Camp MacKall and Fort Bragg, NC MCB Camp Lejeune, NC	SAR	G3	NC: S3	NC: C-SC
Wild Indigo, Hairy	*Baptisia calycosa* var. *villosa*	NAS, Whiting Field, FL	SAR	G2T1 T2	FL: S1S2	FL: LT
Yellow-eyed Grass, Drummond's	*Xyris drummondii*	Eglin AFB, FL Tyndall AFB, FL	SAR	G3	FL: S2	FL: Not Listed
Yellow-eyed Grass, Harper's	*Xyris scabrifolia*	Tyndall AFB, FL	SAR	G3	FL: S1	FL: LT
Yellow-eyed Grass, Quillwort	*Xyris isoetifolia*	Tyndall AFB, FL	SAR	G2	FL: S2	FL: Not listed
Grasses, Rushes, and Sedges						
Dropseed, Pine Barrens	*Sporobolus* sp. 1	MCB Camp Lejeune, NC	SAR	G5	NC: S1	NC: E
Grass, Curtis' Sand	*Calamovilfa curtissii*	Eglin AFB, FL Hulburt Field, sub: Eglin AFB, FL NAS, Whiting Field, FL	SAR	G2	FL: S2	FL: LE
Grass, Southern Three-awned	*Aristida simpliciflora*	Camp Shelby, MS	SAR	G3	MS: S1	MS: Not listed

(Sheet 3 of 3)

Table A3
Federally Listed and Candidate Animal Species and Animal Species at Risk Known To Occur in the Pine Flatwoods Community on at Least One Military Installation in the Southeastern United States

Common Name	Scientific Name	Installation	Federal Status	Status on Installation
Mammals				
Bear, Florida Black	*Ursus americana floridanus*	Camp Blanding, FL Eglin AFB, FL	SAR	Documented
Birds				
Kestrel, Southeastern American	*Falco sparverius paulus*	Fort Rucker, AL	SAR	Potential
		Anniston AD, AL		Potential
		Camp Blanding, FL		Documented
		Eglin AFB, FL		Potential
		Fort Gordon, GA		Documented
		Fort Benning, GA		Potential
		Louisiana AAP, LA,		Documented
		Fort Jackson, SC		Documented
Sparrow, Bachman's	*Aimophila aestivalis*	Anniston AD, AL	SAR	Potential
		Fort Rucker, AL		Potential
		Eglin AFB, AL		Documented
		Camp Blanding, FL		Documented
		Fort Stewart, GA		
		Fort Gordon, GA		Documented
		Fort Benning, GA		Documented
		MCLB Albany, GA		Documented
		Camp Beauregard, LA		
		Fort Polk, LA		Documented
		Camp Shelby, MS		
		Fort Bragg, NC		Documented
		Fort Jackson, SC		Documented
		Fort Picket, VA		
		Fort A.P. Hill, VA		

(Sheet 1 of 3)

Table A3 (Continued)

Common Name	Scientific Name	Installation	Federal Status	Status on Installation
Birds (Continued)				
Woodpecker, Red-Cockaded	*Picoides borealis*	Camp Blanding, FL	E	Potential
		Eglin AFB, FL		
		Fort Benning, GA		Documented
		Fort Stewart, GA		Documented
		Fort Gordon, GA		Potential
		MCLB Albany, GA		Potential
		Fort Jackson, SC		Documented
		NWS Charleston, SC		Documented
		Camp Shelby, MS		
		MOT Sunny Point, NC		Documented
		Fort Bragg, NC		Documented
		Fort McClellan, AL		Potential
		Fort Polk, LA		Documented
		Louisiana AAD, LA		Potential
Reptiles				
Snake, Eastern Indigo	*Drymarchon corais couperi*	Camp Blanding, FL	T	
		Eglin AFB, FL		
		Homestead NSGA		Potential
		Fort Stewart, GA		Documented
		Fort Gordon, GA		Potential
		Fort Benning, GA		Potential
		MCLB Albany, GA		Potential
		Camp Shelby, MS		
Snake, Pine (Florida, Black, Northern)	*Pituophis melanoleucus mugitus*	Anniston AD, AL	SAR	Potential
		Camp Blanding, FL		Documented
		Eglin, AFB, FL		
		Fort Stewart, GA		
		Fort Gordon, GA		Documented
		Fort Benning, GA		Documented
		Fort Polk, LA		Documented
		Camp Shelby, MS		
		Fort Bragg, NC		Documented
		Camp MacKall, NC		
		Fort Jackson, SC		Potential

(Sheet 2 of 3)

Table A3 (Concluded)

Common Name	Scientific Name	Installation	Federal Status	Status on Installation
Amphibians				
Frog, Gopher (Dusky, Carolina, Florida)	*Rana areolata* spp.	Camp Blanding, FL	C/SAR	Documented
		Eglin AFB, FL		
		Fort Stewart, GA		Documented
		Fort Gordon, GA		Potential
		Fort Benning, GA		Documented
		Camp Shelby, MS		
		Fort Bragg, NC		Potential
		Camp MacKall, NC		
		MOT Sunny Point, NC		
Salamander, Flatwoods	*Ambystoma cingulatum*	Camp Blanding, FL	C	Potential
		Eglin, AFB, FL		
		Fort Stewart, GA		
		MCLB Albany, GA		
				Potential

(Sheet 3 of 3)

Table A4
State-Listed Plant Species Occurring in the Pine Flatwoods Community on Installations in the Southeast Region (Refer to Table A2 legend for description of status and global rankings)

Common Name	Scientific Name	Installation	Global Rank	State Rank	State Status
Wood Plants					
Buckbrush, Little-leaf	*Ceanothus microphyllus*	MCLB Albany, GA	G4G4	GA: S2	GA: Not listed
Holly, Myrtle	*Ilex myrtifolia*	Camp Villerie, LA	G5	LA: S2S3	LA: Not listed
St. John's-Wort, Carolina	*Hypericum nitidum*	MCB Camp Lejeune, NC	G4	NC: S1	NC: SR
Forbs					
Asphodel, False Coastal	*Tofieldia racemosa*	Camp Villerie, LA	G5	LA: S2S3	LA: Not listed
Dragon-head, Apalachicola	*Physostegia godfreyi*	Tyndall AFB, FL	G3	FL: S3	FL: Not listed
False Foxglove, Flaxleaf	*Agalinis linifolia*	Camp Villerie, LA	G3G4	LA: S1	LA: Not listed
False Foxglove, Leafless	*Agalinis aphylla*	Fort Stewart, GA MCB Camp Lejeune, NC	G3G4 G3G4	GA: S1S2 NC: S2	GA: Not listed NC: C
Gerardia, Branched	*Agalinis virgata*	MCAS Cherry Point, NC MCB Camp Lejeune, NC	G3G4	NC: S1	NC: C
Goldencrest	*Lophiola aurea*	Camp Villerie, LA	G3G4	LA: S2S3	LA: Not listed
Lily, Southern Red	*Lilium catesbaei*	Eglin AFB, FL Tyndall AFB, FL	G4	FL: S3	FL: LT
Milkweed, Savanna	*Asclepias pedicellata*	MCB Camp Lejeune, NC	G3G4	NC: S2	NC: C
Milkwort, Hooker's	*Polygala hookeri*	MCB Camp Lejeune, NC	G3	NC: S2	NC: C
Orchid, Green-fly	*Epidendrum conopseum*	Moody AFB, GA	G3G4	GA: S3	GA: U
Orchid, Green-fringed	*Plantanthera lacera*	Camp Shelby, MS	G5	MS: S1S2	MS: Not listed
Orchid, Michaux's	*Habenaria quinqueseta*	Fort Stewart, GA	G4G5T	GA: S1	GA: Not listed
Orchid, Pogonia	*Cleistes divaricata*	Camp Villerie, LA	G4	LA: S1	LA: Not listed

(Continued)

Table A4 (Concluded)

Common Name	Scientific Name	Installation	Global Rank	State Rank	State Status
Forbs (Continued)					
Pipewort, Texas	*Eriocaulon texense*	Camp Shelby, MS	G3G4	MS: S2S3	MS: Not listed
Pitcherplant, Hooded	*Sarracenia minor*	Camp Blanding, FL Fort Stewart, GA Moody AFB, GA	G4G5	Not Listed GA: S4	Not Listed GA: U
Pitcherplant, Sweet	*Sarracenia rubra*	Eglin AFB, FL	G3	FL: S2	FL: LE
Pitcherplant, Sweet	*Sarracenia rubra gulfensis*	Fort Benning, GA	G3	GA: S1	GA: E
Redroot, Carolina	*Lachnanthes caroliniana*	Camp Villerie, LA	G4	LA: S2S3	LA: Not listed
Sundew, Spoon-leaved	*Drosera intermedia*	Eglin AFB, FL NAS Pensacola, FL	G5	FL: S3	FL: LT
Wild Petunia, Night-flowering	*Ruellia noctiflora*	Camp Villerie, LA	G3	LA: S1	LA: Not listed
Yellow-eyed Grass, Chapman's	*Xyris chapmanii*	Camp Shelby, MS	G2G3?	MS: S2?	MS: Not listed
Yellow-eyed Grass, Elliott's	*Xyris elliottii*	MCB Camp Lejeune, NC	G4	NC: S1	NC: SR
Yellow-eyed Grass, Savanna	*Xyris flabelliformis*	MCB Camp Lejeune, NC	G4	NC: S1	NC: C
Grasses, Rushes, and Sedges					
Beak Rush, Flat-fruited	*Rhynchospora compressa*	Camp Villerie, LA	G4	LA: S2	LA: Not listed
Flatsedge, Leconte's	*Cyperus lecontei*	MCB Camp Lejeune, NC	G4?	NC: S1	NC: SR
Panic Grass, Southeastern	*Panicum tenerum*	MCB Camp Lejeune, NC	G3G4	NC: S2	NC: SR
Maidencane, Blue	*Amphicarpum muhlenbergianum*	Moody AFB, GA	G?	GA: S1	GA: Not listed
Pond Rush	*Cladium mariscoides*	Eglin AFB, FL	G5	FL: S1	FL: Not listed
Witchgrass, Erectleaf	*Dichanthelium erectifolium*	MCB Camp Lejeune, NC	G4	NC: S2	NC: SR
Mosses					
Moss, Fitzgerald's Peat	*Sphagnum fitzgeraldii*	Camp Lejeune, NC	G2G3	NC: S2S3	NC: SR

Table A5
Additional Threatened, Endangered, and Candidate Plant Species and Species of Concern That Could Potentially Occur in the Pine Flatwoods Community on Installations in the Southeastern Region (Abrahamson and Hartnett 1990; Jordan, Wheaton, and Weiher, 1995; Martin 1992a-e)

Common Name	Scientific Name	Federal Status
Woody Plants		
Indigo-bush, Savanna	*Amorpha georgiana* var. *confusa*	SAR
Pawpaw, Beautiful	*Deeringothamnus pulchellus*	E
Pondspice	*Litsea aestivalis*	SAR
Forbs		
Ascyrum, Edison's	*Hypericum edisonianum*	SAR
Balduina, Purple	*Balduina atropurpurea*	SAR
Beargrass, Florida	*Nolina atropurpurea*	SAR
Bogmint, Carolina	*Macbridea caroliniana*	SAR
Boneset, Resinous	*Eupatorium resinosum*	SAR
Coneflower, Sunfacing	*Rudbeckia heliopsidis*	SAR
Cowbane, Canby's	*Oxypolis canbyi*	E
Eulophia	*Pteroglossaspis ecristata*	SAR
Gentian, Wiregrass	*Gentiana pennelliana*	SAR
Grass-of-Parnassus, Carolina	*Parnassia caroliniana*	SAR
Ixia, Fall-flowering	*Nemastylis floridana*	SAR
Lily, Panhandle	*Lilium iridollae*	SAR
Lobelia, Boykin's	*Lobelia boykinii*	SAR
Meadowrue, Cooley's	*Thalictrum cooleyi*	E
Pennyroyal, Mock	*Hedeoma graveolens*	SAR
Pitcher plant, Wherry's Sweet	*Saracenia rubra* var. *wherryi*	SAR
Plantain, Pineland	*Plantago sparsifolia*	SAR
Rattleweed, Hairy	*Baptisia arachnifera*	E
Scareweed	*Baptisia simpliciflora*	SAR
Spurge, Telephus	*Euphorbia telephioides*	T
St. John's-wort, Bog	*Hypericum adpressum*	SAR
Trillium, Carolina Least	*Trillium pusillum* var. *pusillum*	SAR
Grasses, Rushes, and Sedges		
Dropseed, Wireleaf	*Sporobolus teretifolius*	SAR
Mosses		
Campylopus, Savanna	*Campylopus carolinae*	SAR

from litter may be responsible for increased vigor observed in populations of some sensitive plant species following fire (Abrahamson and Hartnett 1990).

Historically, fires resulting from lightning strikes burned longleaf pine communities during the growing season (Abrahamson and Hartnett 1990). Before habitats became fragmented by human activities, fires spread naturally, sometimes burning areas the size of several counties (Noss 1988). In addition, fires have been set by humans for the purpose of hunting since the early aborigines (Abrahamson and Hartnett 1990). Since European settlement, and most notably in the first half of this century, fragmentation, fire suppression, and alteration of the fire season have eliminated the possibility of a natural fire regime in this community. Activities that can lead to fire suppression in pine flatwoods are listed in Table A6.

Table A6
Activities That Lead to Fire Suppression in Pine Flatwoods

Activity(ies)	Effect(s)
Land conversion	Fragments landscape so wildfires cannot spread over large areas.
Creation of ditches, plow lines	Fire exclusion.
Pine straw harvest	Actively removes fuel, can keep a low-intensity fire from occurring (Russo et al. 1993), and can seriously disrupt the natural reinvestment of nutrient capital and ecological processes (Maser 1988).
Use of heavy equipment	Used for site preparation; this disturbs the upper soil horizon and reduces wiregrass cover, removing fuel.
Fire suppression, or alteration in frequency, season	In the long term, this leads to natural fire suppression by favoring plant species that no longer promote fire.

a. *Plants*. Prior to active fire suppression, this community may have been dominated by longleaf pine, while slash pine was confined to areas that experienced lower fire frequency. However, fire suppression, in addition to logging of longleaf pine, planting of slash pine outside of its natural range, and the introduction of feral hogs (*Sus scrofa*; which prefer longleaf pine seedlings over other pine seedlings as a food source), may have allowed the less fire-tolerant slash pine to dominate areas formerly occupied by longleaf pine (Ware, Frost, and Doerr 1993).

Native plants species in this community also require frequent, growing season fire, which is necessary to maintain open conditions required for their survival and stimulate flowering in many cases. Wiregrass, for example, does not normally flower unless the community is burned in spring or summer (Abrahamson and Hartnett 1990). Little bluestem (*Schizachyrium scoparium*) and other bluestem grasses (*Andropogon* spp.) flowered much more conspicuously following growing season

burns than dormant season burns in a North Florida study (see Robbins and Myers 1992). Smooth bog-asphodel (*Tofieldia glabra*), a Federal species at risk, exhibits greatest seed production 1 to 2 years after a growing season burn (Russo et al. 1993). Although many herbaceous species are able to flower after winter burns, flowering is less synchronous (Platt, Evans and Davis 1988a). Synchronized flowering may attract more pollinators, increasing chances of seed set. Whether the herbaceous species in this community depend most on vegetative or sexual reproduction is not always clear. Regardless of the dominant means of reproduction for rare species, evidence suggests that suppression of growing season fires quickly leads to the development of a dense shrub understory, followed by thinning of the herbaceous layer due to shading (Christensen 1988; Stout and Marion 1993; Ware, Frost, and Doerr 1993). Walker and Peet (1983) showed that unburned pine flatwoods in North Carolina were consistently less diverse than frequently burned pine flatwoods, and Roberts and Oosting (1958) found that fire suppression resulted in exclusion of shade-intolerant pine flatwoods species, including the Venus' flytrap (*Dionaea muscipula*; Christensen 1988). Winter burns, although they are useful for reducing fuel loads, are not as effective as growing season burns at killing understory trees and shrubs (Robbins and Myers 1992).

b. Animals. Native animal species in and adjacent to this community are also dependent on frequent fire to maintain suitable habitat conditions. Fire suppression has been implicated as a major factor contributing to the decline of all animal TES associated with this community and adjacent communities (e.g., sandhills). For example, fire suppression in longleaf pine communities allows development of a thick herbaceous understory that creates unsuitable breeding habitat for Bachman's sparrows (Dunning 1993) and postlarval habitat for flatwoods salamanders (Palis 1995b). Gopher tortoise density can decline dramatically when fire is excluded (Diemer 1989); this in turn may harm gopher frog populations that often rely on gopher tortoise burrows for diurnal retreats (Godley 1992). Fire suppression in pine and pine/oak uplands is also detrimental to indigo snakes because of the loss of gopher tortoise habitat; however, the overall importance of this plant community to indigo snakes during summer is unknown. Eastern indigo snakes have been located in pine flatwoods of both Georgia (Diemer and Speake 1983) and Florida (Moler 1985). Fire suppression also allows development of a dense hardwood midstory, which is unsuitable nesting habitat for red-cockaded woodpeckers (Hovis and Labisky 1985; Conner and Rudolph 1989). Means, Palis, and Baggett (1994) attributed flatwoods salamander population declines in Florida to the loss of groundcover vegetation partially due to fire suppression; however, no information was available on recommended fire-frequency or season of burn.

The faunal species present in flatwoods is also a consideration when determining season of burning. Growing-season burns were recommended by Palis (1995a) for gopher frogs because these do not interfere with breeding or seasonal movements to and from breeding sites. Furthermore, growing-season fires pass through breeding ponds that are dry during this time, making them more suitable by reducing herbaceous and woody vegetation.

Alteration of hydrology. Wet pine flatwoods often have an organic or clay hardpan near the surface, causing water from rainfall to remain on the surface instead of percolating through the soil. In addition, the water table is located below the hardpan. As a result, wet pine flatwoods often have saturated soils with standing water in the winter and early spring when transpiration is low, and dry soils during the growing season resulting from increased transpiration and lack of water movement upward through the subsurface hardpan (Martin 1992a-e).

Altered hydrology in one community is likely to affect hydrology in adjacent communities. Effects of ditches and canals can extend far beyond the communities for which they were intended, lowering the maximum height and duration of the soil water tables on nearby lands. Roadside ditches quickly drain the water in pine flatwoods after heavy rains, inducing greater peak flows into the streams and lowlands where the water is discharged. Altered hydrology in upland communities can lead to erosion and deposition of silt in lower lying communities, raising the soil surface and directly impacting plants in the lower lying community (Brown, Stone, and Carlisle 1990). Activities that lead to alteration of hydrology in this community are listed in Table A7.

a. *Plants*. A common characteristic of wetland communities, including wet pine flatwoods, is that slight differences in elevation result in different environmental conditions for establishing plants. Lower lying areas may range from saturated to moist year round, while elevated areas dry out in the summer. Plants occurring within these communities can have narrow environmental tolerances and will be affected directly by slight alterations in hydrology. For example, Venus flytrap, a Federal species at risk endemic to the Coastal Plain of the Carolinas, is limited to soils having a high water table, an organic hardpan usually not more than 60 cm below the surface, and a pH range of 3.9 to 4.5 (Roberts and Oosting 1958 in Russo et al. 1993). This species requires soils that are wet to moist throughout most of the year and cannot survive in areas that become too dry. In addition, it does not typically occur in sites that are semipermanently or permanently flooded (Russo et al. 1993). For these reasons and because this species also requires high light conditions of open areas, Venus flytrap seldom occurs outside of ecotones adjacent to sandhills, pine flatwoods, and pocosins (Russo et al. 1993). Normally, these ecotones are moist year-round, but changes in hydrology can lead to either drying out or to semipermanent or permanent saturation, which will eliminate habitat for Venus flytrap and other sensitive species requiring similar

Table A7
Activities That Alter the Hydrology in Pine Flatwoods

Activity(ies)	Effect(s)
Creation of fire plow lines, scrapes, roadside ditches, excavations	May channel water away from the community.
Bedding for plantations	Permanently raises the soil surface so that it no longer becomes saturated.
Use of heavy equipment	Creates wheel ruts, which become invaded by more hydrophytic species, and wheel ridges, which become invaded by more xerophytic species. In addition, wheel ruts in wet areas of pine flatwoods (possibly in or adjacent to bog inclusions, or in ecotonal areas) may cause channelization of water; the ruts fill with water that had previously been distributed over a larger surrounding area; the surrounding area supporting wetland species becomes dry and will no longer support them.[1]
Use of heavy equipment and grazing by livestock	Compacts soil, causing decrease in water infiltration and percolation through soil.
Fire suppression	Leads to increased moisture, by allowing litter, which holds moisture, to accumulate, and leads to changes in plant biomass and organics. Changes community composition, which can lead to breakdown in hardpan (Abrahamson and Hartnett 1990).[2]

[1] Personal Communication between Mary Harper and Rhonda Stewart in 1995. Personal Observation in 1995.
[2] Oaks, for example, are noted for their ability to penetrate the hardpan, increasing permeability (in Abrahamson and Hartnett 1990).

conditions (e.g., rough-leaved loosestrife (*Lysimachia asperulaefolia*), savanna cowbane (*Oxypolis ternata*), pale beaksedge (*Rhynchospora pallida*), Carolina goldenrod (*Solidago pulchra*), and Carolina asphodel (*Tofieldia glabra*); Russo et al. 1993).

Herbaceous species can also be impacted indirectly by changes in hydrology, when these alterations create better conditions for competing species. For example, planted slash pine and understory shrubs growing on wet, phosphorous-deficient soil can have much higher growth rates in the vicinity of roadside ditches, which can cause drainage within short distances of the road (around 10 to 30 m; Brown et al. 1990). Higher growth rates of slash pine and shrubs reduce survival and growth of herbaceous species through shading (Brown, Stone, and Carlisle 1990).

b. *Animals*. Altered hydrology in and adjacent to pine flatwoods is likely to most significantly impact amphibian TES populations. Ditching or berming of small wetlands can result in lowered water levels or shortened hydroperiods (Marois and Ewel 1983), which can make breeding

sites for amphibians unsuitable. Both gopher frogs and flatwoods salamanders breed in ephemeral depressional wetlands in or adjacent to pine flatwoods.

Soil disturbance and direct impacts to rare plant species. Soil disturbance physically destroys plants and their habitats. This affects the community by reducing habitat and population sizes; but unless soil disturbance is intense and over large areas of the community, effects are less extreme than those caused by alterations in hydrology, fire suppression, or land conversion. The effects of soil disturbance are known for few species in this community, including wiregrass, which is difficult to reestablish once eliminated (Frost, Walker, and Peet 1986). Activities that disturb the soil or directly impact plant species in pine flatwoods are listed (Table A8).

Table A8
Activities That Disturb the Soil or Cause Direct Impacts to Plant Species in Pine Flatwoods

Activity(ies)	Effect(s)
Creation of fire plow lines	Destroys habitat and plants. Often placed in ecotones, which provide critical habitat for several rare species.
Use of mechanized vehicles for site preparation, logging, pine straw harvest, pine beetle control	Can lead to significant soil compaction, or create wheel ruts, which destroy habitat and plants (Lowery and Gjerstad 1991). Generally, damage is most extensive when soils are wet.
Stump removal, windthrowing, disking, bedding, clay and sand removal	Mix soil horizons and expose mineral soil, which leads to increased erosion, siltation, and changes in herb species richness (Abrahamson and Hartnett 1990; Lowery and Gjerstad 1991; Department of the Air Force 1993).
Collecting	Can lead to significant declines in rare plant populations. A problem for Venus flytrap (*Dionaea muscipula*), Chapman's rhododendron (*Rhododendron chapmanii*), and others.

Rare plant populations within this community appear to be most threatened by the placement of fire plow lines in ecotones. The ecotone between pine flatwoods and pocosins is generally too wet to support trees, but contains enough dry fuel to carry fire into the pocosin border. Fire kills invading pocosin shrubs and maintains the open conditions required by many rare plant species (see Alteration of hydrology). Managers traditionally placed fire plow lines in the ecotone between pine flatwoods and pocosins, directly impacting rare plants and their habitats. If placed farther up the elevational gradient, fire plow lines may exclude fire and allow shrubs to invade ecotones. Two of the sites for rough-leaved loosestrife, located in a National Forest, were nearly destroyed by placing fire plow lines in ecotones (Frost, Walker, and Peet 1986).

Herbicide/pesticide application and pest management. Herbicides and pesticides are potentially damaging to rare species. Herbicides are sprayed on sites being prepared for pinestraw harvest (Russo et al. 1993) and are applied in site preparation to decrease sprouting of competing hardwoods (Lowery and Gjerstad 1991).

Pesticides are also applied for pine-beetle management (Department of the Air Force 1993). A list of predicted effects of red-cockaded woodpecker management on the potential endangered, threatened, and sensitive plants of the United States Forest Service suggested that herbicide use to control midstory growth has an indirect, positive effect on rare plant species in wet savannas, because it leads to increased light levels reaching the herbaceous ground layer.[1] When herbicides are applied directly to target vegetation, effects on rare species should be minimal. However, when herbicides are applied to target vegetation using broadcast application methods, rare species are likely to be impacted negatively.

Fertilization. Fertilization in pine flatwoods may have drastic effects on these communities because they are naturally low in nutrients, and weedy species are likely to invade following nutrient enrichment. Also, Walker and Peet (1983) reported that diversity in savannas increased as productivity decreased. Fertilization experiments demonstrated that in frequently burned savannas, productivity doubled after fertilization, whereas in less frequently burned savannas, fertilization resulted in a much lower increase in productivity. An increase in productivity resulting from fertilization should lead to a decline in plant species richness, including a decline in rare plant species richness. Walker and Peet (1983) did not evaluate whether fertilization led to replacement of rare species by more competitive species able to thrive under fertilized conditions.

Fertilization may be intended, or may result inadvertently from activities in the surrounding landscape. Predicted changes in vegetation as a result of fertilization include an increase in bunchgrasses and more rapid invasion by shrubs and saplings (Frost, Walker, and Peet 1986). Fertilizer that carries into aquatic habitats via runoff can contribute to eutrophication (e.g., algal blooms). Larval flatwoods salamanders are noticeably absent from fertilizer-impacted wetlands (Palis 1995b). Several activities can lead to increased fertility in this community (Table A9).

Exotic species. Undisturbed pine flatwoods that burn frequently do not appear to be vulnerable to invasion by exotic plant species except in South Florida. Undisturbed and disturbed moist pine flatwoods in South Florida have been extensively invaded by the Australian cajeput (*Melaleuca quinquenervia*), Brazilian pepper (*Schinus terebinthifolius*), and downy myrtle (*Rhodomyrtus tomentosus*; Abrahamson and Hartnett 1990).

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[1] Personal Communication, 4 October 1994, D. Krusac, Endangered Species Specialist, Southern Region, U.S. Forest Service.

Table A9 **Activities That Lead or Could Potentially Lead to Increased Fertility in Pine Flatwoods**
Fertilization during site preparation (Frost, Walker, and Peet 1986), or nutrient runoff from fertilization in adjacent upland communities (Department of the Army 1994), or fertilization accompanying revegetation activities.
Input of fine nutrient dust from fertilized agricultural fields (Frost, Walker, and Peet 1986).
Smokestack output from burning fossil fuels (Frost, Walker, and Peet 1986).
Nutrient fixation by automobile engines (Frost, Walker, and Peet 1986).

Activities that disturb soil or alter hydrology, especially bulldozing of roads and fire lanes, increase susceptibility of pine flatwoods to invasion by species not natural to the community. Old field weed floras may invade following disturbances; this may reduce fire frequency and facilitate hardwood invasion (Abrahamson and Hartnett 1990). Exotic Cogon grass (*Imperata cylindrica*) now occurs on Eglin AFB, FL. This species is capable of dominating the understory of pinelands, to the exclusion of other species (FNAI 1994b). It is spread by wind-dispersed seed and by rhizomes, which are transported on equipment (e.g., bulldozers).

Feral hogs appear to pose the most serious exotic species threat to pine flatwoods. At Eglin AFB, FL, hog activity kills plants directly, increases soil erosion, and facilitates weedy species invasion; hog activity can degrade habitats so severely that they are no longer able to support native ground cover and rare species (FNAI 1994b). Activities that may increase susceptibility of pine flatwoods to invasion by exotic species are listed (Table A10).

Table A10
Activities That May Lead to Invasion of Pine Flatwoods by Plant Species That are not Native to the Community

Activity(ies)	Effect(s)
Hog rooting	Destroys vegetation and churns up soil, freeing resources for the establishment of exotics. Feral hogs may also be responsible for transporting non-native propagules into the community.
Fire suppression	Changes physical characteristics of community so that native species cannot establish, thereby freeing resources for non-natives.
Establishing clearings for wildlife food plots	Provides open areas that are easily invaded by exotics or species from adjacent communities (Leblond, Fussell, and Braswell 1994a). Can also foster establishment of exotics if exotic species are planted as wildlife food sources.
Fire plow lines	Suppress fire and create open spaces, freeing resources for non-natives.
Revegetation	Allows for establishment of non-natives, when they are intentionally planted in revegetation activities.

Alteration of community structure. Alteration of community structure leads to different conditions for establishment of plants. For example, herbaceous species that require high light conditions in the understory may be eliminated or suffer population declines if a shrub layer is allowed to develop in a community, when it was not there previously. This has often been the case with pine flatwoods, where long-term fire suppression has lead to the development of a dense shrub layer. Similarly, activities that alter the plant community structure and composition can alter animal communities. Activities that alter community structure are listed below (Table A11).

Table A11
Activities That Lead to Changes in Community Structure in Pine Flatwoods

Activity(ies)	Effect(s)
Fire suppression	Turns an open, bilayered community into a closed community with a well-developed shrub layer.
Mechanically chopping vegetation in site preparation	Reduces shrub cover and leads to an increase in herb richness, but also causes wiregrass to decrease significantly in cover and frequency (Abrahamson and Hartnett 1990). May physically disrupt vegetation or uproot bunchgrasses.
Bedding for plantations	Adds flats, beds, and furrows, introducing environmental heterogeneity (Abrahamson and Hartnett 1990).

Conflicting uses. Management for domestic livestock does not appear to be a concern in this community on military installations in the Southeast. When it does occur, grazing can result in alteration of soil properties and vegetation structure. In areas that have been grazed for long periods of time, soil becomes compacted, reducing water infiltration and percolation (Myers and Ewel 1990). Livestock grazing in pine flatwoods resulted in increased grass production, changes in floristic composition, and decreases in herb production at dry sites (Duvall and Linnartz (1967) in Myers and Ewel 1990). Others have suggested that heavily grazed areas support high species richness, because grazing prevents potentially competitive species from attaining maximum size and vigor (reviewed in Walker and Peet 1983). However, plant species surviving in heavily grazed areas are more likely to be those common to roadsides and waste places than species that are rare (Walker and Peet 1983).

Military activities. Military activities can have positive, neutral, or negative effects on pine flatwoods communities; these are summarized in Table A12. Military land use can promote the maintenance of pine flatwoods communities. The most significant beneficial impact is the reintroduction of fire from activities such as live arms firing and use of incendiary devices. The high frequency of ignition on military installations, especially in high hazard impact areas, often produces a fire regime over large areas at a

Table A12
Military Activities and Their Potential for Impacting Pine Flatwoods

Positive Effects	Neutral Effects	Negative Effects
Munitions: Introduction of frequent fire.	Training on foot: Neutral at low intensity, especially in drier pine flatwoods.	Earthmoving activities: Alteration of water flow, mixing of soil horizons.
Camouflage training: Hand removal of hardwood midstory.	Use of tactical land vehicles: Neutral at low intensity, especially in drier pine flatwoods.	Bivouacking: Destruction of ground cover, soil compaction, potential for fragmentation. Assembly/staging: Destruction of ground cover, soil compaction, fragmentation. Use of tactical land vehicles: Destruction of ground cover, alterations of hydrology and soils at high intensity, fragmentation.

frequency that resembles presettlement natural fire return intervals. This encourages a mosaic burn pattern and enhances conditions for the fire-adapted species, including those associated with pine flatwoods (Gulf Engineers and Consultants, Inc., and Geo-Marine 1994; LeBlond, Fussell, and Braswell 1994a; see Fire suppression).[1,2]

Low-intensity, nonmechanized activities, such as troop movements on foot, are not known to have significant positive or negative impacts. The plants that inhabit pine flatwoods are adapted to periodic loss of their aboveground parts, and they can recover from light, periodic trampling. Similarly, the direct impacts from low-intensity, individual vehicle ruts are not significantly detrimental, until creation of ruts is frequent and extensive enough to lead to erosion.[1] This effect depends on the hydrology of the pine flatwoods—drier sites can withstand more intense training activities than wetland areas such as pine savannas. At some unknown level of intensity, the use of tactical land vehicles (both tracked and wheeled) will cause extensive rutting, which leads to gully formation and channeling of both water and nutrients away from the community, usually into lower areas such as streambeds (Russo et al. 1993). This will significantly alter the community structure and composition until natural water flow is restored (LeBlond, Fussell, and Braswell 1994a). It has been noticed that the impacts to soils and hydrology can favor loblolly pine over longleaf and slash pines[3] (see Alteration of hydrology). Disruption of the natural hydrologic regime is a very serious impact to these communities—prescribed burning alone cannot maintain these communities if the water flow is channelled away through ditching and rutting (FNAI 1994).

1 Personal Communication, 12 May 1995, A. Weakley.

2 Personal Communication, 24 July 1995, R. Stewart.

3 Personal Communication, 10 May 1995, R. Stewart.

Further impacts from vehicle traffic include soil disturbance and direct damage to vegetation (see Soil disturbance and direct impacts to rare species). Pine flatwoods can be impacted by soil disturbances within the community itself or by sedimentation from erosion on nearby roads and trails. Removal of vegetation and creation of large areas of bare, highly compacted soil is caused by bivouacking and assembly activities, involving both foot traffic and vehicle use. Tactical maneuver training creates localized rutting with altered hydroperiods. These changes encourage invasion of the community by inappropriate species. Recovery efforts have discovered that the native grasses are very difficult to re-establish once they have been removed.[1] Once the bunch grasses are removed, fire can no longer spread throughout the community, and a dense understory will prevail. However, some early successional, native ground cover species show regrowth when bare sites in bivouac areas are rested (A. Trame, M. Harper, personal observation). The conditions that determine whether or not community recovery occurs are not understood.

Conclusions. Other than direct destruction of this community, the main impacts to pine flatwoods are fire suppression and alteration of hydrology (often by the creation of fire plow lines, bedding for plantations, or tactical land vehicle maneuver training). Although many reports suggest that fire suppression is the most serious threat to this community, fire suppression may have been less of a problem on military installations, while alteration of hydrology may have been more important. Furthermore, as long as the community has burned frequently enough to retain enough wiregrass to spread fire, damage appears to be reversible. Conversely, changes in hydrology may be more permanent. The main impact to rare species populations in pine flatwoods on installations appears to be the placement of fire plow lines in ecotones. Hog rooting, although not reported to be a problem on many installations, has potential to become a serious threat to the integrity of pine flatwoods.

Indicators of community quality

High-quality pine flatwoods exhibit a bilayered structure with an open pine overstory and a diverse herbaceous understory, dominated by wiregrass east of eastern Mississippi. They are characterized by frequent fire, natural hydrological regimes, and naturally regenerating longleaf pine. The community should support rare species. These communities are in close approximation to their natural state, and should be composed of species common to this community (see Dominant or characteristic plant species). Communities that have been subjected to fire suppression may have developed a dense shrub understory. However, if the ground cover (including wiregrass within its natural range) is still intact, and hydrology has not been altered significantly, ecosystem function and viability can be restored (e.g., ability to spread fire, nutrient cycling). These communities should still have a good representation and

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[1] Personal Communication, 12 May 1995, A. Weakley.

distribution of characteristic plant species (Department of the Air Force 1993). A community in this condition has good potential for recovery.

Community restoration will be difficult if the herbaceous ground cover has been completely eliminated by long-term fire suppression, high-intensity site preparation or intensive silviculture (Noss 1988), or if hydrology has been significantly altered. These communities will not retain a good representation and distribution of characteristic plant species (Department of the Air Force 1993). However, if communities in this condition exist as patches within a larger mosaic of natural communities, restoration may be of value to the ecosystem because it will lead to decreased fragmentation.

Lowest quality communities are those not restorable because they have been converted for other uses and no longer contain species characteristic to the community. These include cleared test ranges, sewage disposal spray fields, urban areas, main roads, designated clay pits, power line rights-of-way, and some wildlife-urban interface areas (Department of the Air Force 1993).

Plant community management prescription

Management information is based on U.S. Fish and Wildlife Service (USFWS) Recovery Plans, Element Stewardship Abstracts provided by TNC, other documents for individual species occurring in this community on installations, guidelines for managing these communities provided in reports produced at the installations, and literature review. The plant species in this community for which information is available are as follows: American chaffseed (*Schwalbea americana*; Russo et al. 1993), Awned meadowbeauty (*Rhexia aristosa*; Leblond, Fussell, and Braswell 1994a), Carolina goldenrod (*Solidago pulchra*; Russo et al. 1993), Chapman's crownbeard (*Verbesina chapmanii*; Kral 1983), Chapman's rhododendron (*Rhododendron chapmanii*; USFWS 1983), Curtis' sand grass (*Calamovilfa curtissii*; Johnson 1993), Georgia lead plant (*Amorpha georgiana* var. *georgiana*; Russo et al. 1993), hairy wild indigo (*Baptisia calycosa* var. *villosa*; Kral 1983), incised groovebur (*Agrimonia incisa*; Robbins and Hardin 1987), piedmont cowbane (*Oxypolis ternata*; Leblond, Fussell, and Braswell 1994a, 1994b), pine barrens dropseed (*Sporobolis* sp. 1; Leblond, Fussell, and Braswell 1994a), rough-leaved loosestrife (*Lysimachia asperulaefolia*; Russo et al. 1993, USFWS 1993), Venus flytrap (*Dionaea muscipula*; Russo et al. 1993), smooth bog-asphodel (*Tofieldia glabra*; Leblond, Fussell, and Braswell 1994a), southern milkweed (*Asclepias viridula*; Kral 1983), spring flowering goldenrod (*Solidago verna*; Russo et al. 1993), tiny bog buttons (*Lachnocaulon digynum*; Bridges 1986), West's Flax (*Linum westii*; Kral 1983), white-topped pitcher plant (*Sarracenia leucophylla*; TESII 1994), yellow anise tree (*Illicium floridanum*; Kral 1983), yellow coneflower (*Rudbeckia nitida* var. *nitida*; Kral 1983). Available information on the following species, which could potentially occur in this community on installations, was also reviewed: Carolina grass-of-parnassus (*Parnassia caroliniana*; Russo et al. 1993), Cooley's meadowrue (*Thalactricum cooleyi*; Jordan, Wheaton, and Weiher 1995;

USFWS 1994), and Eulophia (*Eulophia ecristata*; Russo et al. 1993). Information was available for all animal TES listed in Table A3. For specific information on management recommendations for individual animal TES, consult species profiles developed for each species.

The first section under each subject is the "recommended" management prescription, or the management suggested when habitat for rare species and community quality are the primary concerns. The second section is an "alternative" management prescription, which is suggested when there are additional concerns.

Prescribed burning.

a. *Recommended.* Little is known concerning the frequency and timing of burning that is most beneficial to the plant species listed above. For plant species in which this information is available and for this community as a whole, burning is recommended during the growing season (usually early in the growing season) to maintain community structure and habitat for plant TES, and in many cases to stimulate flowering and fruiting (Johnson 1993; LeBlond, Fussell, and Braswell 1994a, 1994b; reviewed in Robbins and Myers 1992; Russo et al. 1993; Smith 1994; see Fire suppression). Ware, Frost, and Doerr (1993) suggested that the natural fire return interval in pine flatwoods is every 1 to 3 years. Research indicates that the optimal burn frequency for endangered rough-leaved loosestrife is every 2 years during the growing season, although burning every 3 years should be sufficient to maintain healthy, sexually and asexually reproducing populations (Russo et al. 1993). Populations of endangered American chaffeed are increasing in size in both annually burned areas and in areas burned on a 3-year rotation at Fort Bragg, NC (Russo et al. 1993). Conversely, Georgia lead-plant will not flower or fruit until 2 years after a burn, suggesting that burning too frequently would prevent sexual reproduction in this species (Russo et al. 1993). Walker and Peet (1983) showed that in the Green Swamp, NC, annually burned mesic savannas averaged 26 percent more species per square meter than less frequently burned (fire return interval from 2 to 4 years) savanna. Of 46 species that occurred only in annually burned or only in less frequently burned sites, 36 were found in the annually burned type (Walker and Peet 1983). These results suggest that an average fire return interval of every 2 years may best suit species in this community, and that burning too frequently is less damaging than not burning frequently enough. Compared with longer fire return intervals, burning frequently has advantages for fire managers in that the fire is cooler (because fuel loads are low), moves faster, and creates less smoke.[1] This management appears to be consistent with the recovery plans for Cooley's

[1] Personal Communication, 9 November 1995, J. Murian, Assistant Director for Stewarship, The Nature Conservancy, Altamonte Springs, FL.

meadowrue (USFWS 1994) and rough-leaved loosestrife (USFWS 1993). However, the recovery plan for Chapman's rhododendron recommends prescribed burning using a hot fire every 4 to 5 years, although this recommendation was not based on experimental evidence (USFWS 1983).

These recommendations also appear compatible with native animal species inhabiting this plant community. However, when red-cockaded woodpeckers are present on an installation, there are specific guidelines for prescribed burning in the longleaf pine communities (U.S. Army Construction Engineering Research Laboratories (1994). The red-cockaded woodpecker recovery strategy for the southeastern United States emphasizes growing-season prescribed fires for midstory hardwood control on a 3- to 5-year cycle (Krusac and Dabney 1994), although Army-wide management guidelines call for prescribed burns at least every 3 years (U.S. Army Construction Engineering Research Laboratories 1994). Short burning intervals (i.e., ≤ 3 years) are also recommended for Bachman's sparrows, which greatly benefit from management for red-cockaded woodpeckers (Dunning 1993). Based on limited information currently available for other TES inhabiting this community, these prescribed burning recommendations appear compatible with the maintenance or enhancement of their habitat.

There have been few studies conducted to assess whether early or late growing season burns are most beneficial to the community (Platt, Glitzenstein, and Streng 1989; Robbins and Myers 1992). However, early growing season burns are recommended over late growing season burns for the following reasons: (a) in Florida, lightning fires are most common in early summer, and the largest number of acres are burned naturally during late spring and early summer; (b) studies suggest that early growing season burns are more favorable to growth and survival of longleaf pine seedlings and saplings than late growing season burns; this may be because they help reduce infection rate of brown spot fungus; (c) early growing season fires are more detrimental to hardwoods, which compete with pines for establishment (reviewed in Robbins and Myers 1992). LeBlond, Fussell, and Braswell (1994a,b) have suggested that burns be conducted primarily, but not exclusively, between May and July at MCB Camp Lejeune, North Carolina.

Managers may wish to avoid conducting burns repeatedly during flowering times of rare plant species occurring in their sites (Russo et al. 1994; Smith 1994). However, for many rare plant species, the degree to which their populations rely on sexual versus vegetative reproduction is not known. In addition, some species, such as Cooley's meadowrue, have been observed to resprout and flower later in the season if burned during the early growing season (USFWS 1994).

Regular fire frequency is unnatural at any given site. Varying fire frequency among patches may be necessary to maintain TES as a whole; this will create a mosaic of vegetation conditions and should contribute to species diversity (LeBlond, Fussell, and Braswell 1994a). Therefore, burning more irregularly may be necessary (LeBlond, Fussell, and Braswell 1994a; Robbins and Myers 1992; Glitzenstein, Streng, and Platt 1990). Burning at different times within the growing season may be needed to maintain different species (Platt, Glitzenstein, and Streng 1989).

In areas that have been fire suppressed for long periods, reduction of fuel loads may be necessary so that summer fires do not burn hot enough to damage crowns of adult pine trees. In these cases, winter season burns prior to the initiation of growing season burns are recommended to reduce fuel loads (Department of the Air Force 1993; Robbins and Myers 1992). In addition, burning these sites on short fire rotations for the first several years is recommended until the vegetation and fuel loads have been reduced (Smith 1994). However, management recommendations for Fort Stewart discourage winter burns in areas known to harbor populations of rare amphibians; the authors state that burns in these areas should be conducted prior to October, when newts and salamanders actively begin moving into ponds (Gawin et al. 1995). If it is necessary to burn fire-suppressed areas having high fuel loads, low-intensity burns can be conducted during the growing season if burning takes place when fuel moisture is high (see Gawin et al. 1995).

These recommendations are based on current knowledge. However, because there is little information on the frequency and timing of burn that best suits many species, and because conditions vary from site to site, managers should monitor the effects of their burning schedules on elements of concern. They should be willing to change their management schedules based on response of these elements (e.g., rare species, keystone species, structural elements) to fire frequency and timing, and also on new information as it becomes available.

b. *Alternatives*. When growing season burns cannot be conducted, winter burns and selective removal of unwanted woody species can be used to reduce tree and shrub encroachment (Department of the Air Force 1993; Russo et al. 1993).

Fire prevention.

a. *Recommended*. Natural fire breaks created by moisture should be used whenever possible to contain the fire. Fire should be allowed to spread through the ecotone and into adjacent pocosins (Leblond, Fussell, and Braswell 1994a,b; Russo et al. 1993). When naturally occurring fires must be controlled, the lowest impact method should be used (see Alternatives, below).

b. *Alternative*. If it is necessary to prevent the spread of fires into adjacent communities, existing trails, woods, and roads should be skimmed, cleared, and used as control lines if possible (Department of the Air Force 1993). Otherwise, fire can be controlled using spot fires, chemical fire retardants, and plow lines.

One method of producing spot fires involves dropping plastic containers (balls) of potassium permanganate combined with antifreeze from a helicopter. These will land and set small fires every 15 to 150 m that will burn together before becoming too hot. This is usually used in conjunction with a natural or existing fire break. Managers at Fort Stewart, GA, have used this method to eliminate the use of fire plow lines to maintain a cool ground fire.[1] However, it has been suggested that the burn produced using this method may not be appropriate for rare species management because it can be uniform and even.[2] Natural fire moves slowly in some areas, and fast in others, providing for a mosaic of hot and cool burn areas. It has been suggested that if managers burn in wet conditions, they can get a mosaic burn. They can also place the fires close together or far apart depending on whether they desire cool or hot burns. It is generally recommended that managers use about 13 to 18 balls/ha, but managers at TNC have doubled the number of balls per ha and burned when fuels are damp to achieve a cool, patchy burn.[3]

Managers can use Class A foams to create firebreaks without vegetation destruction. Class A foams reduce the surface tension of water, thus they act as wetting agents. Not all Class A foams are approved for use. Those that are approved have "NFPA Standard 298" or "U.S. Forest Service Qualified/Approved Wildland Fire Foams" on the label or in the enclosed literature.[4] A foam newsletter, entitled "Foam Applications for Wildland and Urban Fire Management," reviews foam products. Free copies can be obtained by contacting the following: Program Leader, Fire Management, USDA Forest Service, Technology and Development Center, 444 East Bonita Avenue, San Dimas, CA 91773-3198, phone: (909)599-1267, FAX: (909)592-2309, product number DG, SDTDC: WO7A.

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1 Personal Communication, 15 February 1995, T. Beaty, Wildlife Biologist, Fort Stewart, GA.

2 Personal Communication, 17 October 1995, Jerome Jackson, Professor, Mississippi State University, MS.

3 Personal Communication, 9 November 1995, J. Marion, Assistant Director for Stewardship, The Nature Conservancy, Altamonte, Springs, FL.

4 Personal Communication, 9 November 1995, Robert Stanton, Fire Consultant, Prescribed Fire Consulting, Oakbrook, IL.

At Eglin AFB, FL, managers control fire using the Class A foam, SILV-EX (by ANSUL), when natural firebreaks cannot be used.[1] Product information states that SILV-EX solution does not destroy or retard new growth, will not harm fish or wildlife, and is biodegradable in both soils and sewage treatment facilities (ANSUL Fire Protection 1991). Users at Eglin AFB state that up to this point, the product has proven to be environmentally friendly.[1] However, there is concern that because of its surfactant properties, SILV-EX may break down the cutins in plants over time.[1] D. Larson has conducted research on effects of SILV-EX foam on mixed-grass prairie and shrubsteppe vegetation in North Dakota.[2] The research in mixed-grass prairie showed that SILV-EX application (0.5-percent solution) did not affect herbaceous biomass accumulation, suggesting little effect on average plant vigor. However, the change in number of plant species per plot was significantly lower after SILV-EX application, regardless of whether or not the plot was burned. These results suggest that the potential effect of SILV-EX foam on species diversity should be considered.[2] Other research has shown negative impacts of foams on aquatic organisms, even at very low concentrations.[3] S. Hamilton cautions that foams also are likely to have negative impacts on amphibians. When there is no danger of input into aquatic systems, foams may be the best solution to using plow lines when natural fire breaks do not occur. However, because so little is known about effects on elements of concern, managers should monitor effects of foam use. They should also be aware of new information on approved foams, available in the foam newsletter.

When it is necessary to control fire using plow lines, existing ones should be reused whenever possible to minimize additional soil disturbances (Department of the Air Force 1993). If new fire plow lines must be developed, they should not be located in ecotonal areas or where rare species occur (Department of the Air Force 1993; LeBlond, Fussell, and Braswell 1994a; Russo et al. 1993). It is important not to place fire plow lines in the ecotone, because ecotones provide habitat for several rare species. Plow lines should not be placed upland from the ecotone, because this will prevent the ecotone from burning. Therefore, plow lines should be placed as far into pocosin sites as possible, so that fire can burn through the ecotone and into the pocosin edge (LeBlond, Fussell, and Braswell 1994a,b). Managers should excavate only the minimum number of plow lines necessary to contain the fire, and only to the minimum depth needed to control the fire

[1] Personal Communication, 11 April 1995, Louis Ballard, Fire Management Officer, Eglin AFB, FL.

[2] Personal Communication, 13 November 1995, Diane Larson, Research Biologist, National Biological Service, Northern Prairie Science Center, Jamestown, ND.

[3] Personal Communications, 20 November 1995, Steve Hamilton, Research Fishery Biologist, National Biological Service, Midwest Science Center, Yankton, SD.

(Department of the Air Force 1993). To minimize erosion, plow lines should be oriented along contours; they should not bisect or tie into waterways or riparian zones, or be placed downhill at right angles to steep slopes (Department of the Air Force 1993).

Plow lines that may erode after a fire should be rehabilitated using native vegetation (Department of the Air Force 1993) and indigenous soil (LeBlond, Fussell, and Braswell 1994a). Abandoned plow lines may also be rehabilitated in the same way (Leblond, Fussell, and Braswell 1994a). At Fort Bragg, NC, managers revegetate plow lines using wiregrass.[1]

Hydrology management.

a. Recommended. The majority of the vascular plant species ($\approx$75 percent of species) listed in Tables A2 and A4 are listed in the *National List of Plant Species That Occur in Wetlands: Southeast (Region 2)* as being either obligate wetland (designated by "OBL"; estimated probability >99 percent) or facultative wetland (designated by "FACW"; estimated probability 67 to 99 percent) species (Reed 1988). Thus, they almost always or usually occur in wetlands, and will be affected by activities that alter hydrology. Therefore, all activities that alter hydrology should be avoided. Most damaging are activities that alter hydrology at the ecosystem level, including draining, ditching, filling, damming, creation of fire plow lines, roads, and new trails (see Alteration of hydrology; Russo et al. 1993; USFWS 1983).

Existing roads, trails, and fire plow lines that disrupt hydrology should be abandoned and allowed to revegetate whenever possible (see Fire prevention above; Russo et al. 1993). Trails that seriously obstruct surface or subsurface water flow should be removed to restore original topography (Russo et al. 1993).

b. Alternatives. When trail or boardwalk construction is necessary, these projects should minimize hydrological or physical damage to the community (Department of the Air Force 1993; Russo et al. 1993). When fire plow lines must be constructed, lowest impact methods should be used (see Fire prevention above). If new logging roads must be constructed, watersheds should be examined beforehand so that ponding of water and disruption of natural hydrology are prevented (Department of the Air Force 1993).

Erosion management.

Recommended. Any activities that might increase erosion and consequently sedimentation into the flatwood-pocosin ecotone or adjacent wetlands, such as

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[1] Personal Communication, 11 May 1995, Janet Shipley, Endangered Species Botanist, Fort Bragg, NC.

pine straw raking, timber harvest, and clay and sand removal on adjacent uplands should be avoided (Russo et al. 1993).

Existing borrow pits should be restored to prevent erosion. This can be accomplished by sloping and contouring the pit walls and seeding them with longleaf pine, or by filling and grassing cuts created by erosion and creating swales to prevent further erosion (Department of the Air Force 1993). When borrow pits are being restored, rare species protection should be ensured (LeBlond, Fussell, and Braswell 1994a). In addition, it is preferable to revegetate with native species, as planting non-natives may lead to future problems if they become invasive.

Pest management.

a. Recommended. Herbicide spraying within or immediately adjacent to rare species or any permanent or seasonal wetlands should be avoided because it affects water quality and presents a direct threat to rare species (Russo et al. 1993; USFWS 1983).

When pests (e.g., southern pine beetles, *Dendroctonus frontalis*) must be controlled, trees should be cut, but should not be sprayed with pesticide. Cut trees can be left onsite or removed, but methods that minimize soil disturbance are preferred. Immediate measures to prevent soil erosion after pine beetle control should then be taken (Department of the Air Force 1993).

Prescribed fire is recommended to control brown spot needle blight (*Scirrhia acicola*). Brown spot needle blight affects longleaf pine during the grass stage (Department of the Air Force 1993).

b. Alternative. If herbicides must be applied, methods and timing should be those that minimize effects on nontarget vegetation and the environment. Only the minimum recommended amount should be used. Herbicides should never be applied aerially. Instead, spot treatments or manual/mechanical broadcast treatments should be implemented (Department of the Air Force 1993).

Rare species/soil management.

a. Recommended. Activities that physically impact rare species such as pine straw raking, timber harvest, heavy equipment use, firebreak construction, harvest of co-occurring plant species, vehicle use, and excessive foot traffic should be avoided (Russo et al. 1993; USFWS 1983).

b. Alternatives. When military training or timber harvest are necessary in this community, they should be conducted during drier times of the year (Lowery and Gjerstad 1991). Pine management using less destructive logging techniques and natural regeneration or planting without first destroying the soil surface is recommended (Russo et al.

1993). If communities that contain rare species are to be used for military training operations, rare plant populations should be delineated and signs reading "Endangered species, restricted area, no vehicles allowed" should be posted (Russo et al. 1993). Similar signs have been posted on Fort Bragg, Camp Mackall, and MCB Camp Lejeune (Russo et al. 1993).

Wildlife management.

a. *Recommended.* Supplemental food plots should not be located in or adjacent to good quality examples of this community. If the community is being burned to benefit game species, the timing of the burn should not harm rare species.

b. *Alternatives.* If food plots and other ground-disturbing wildlife habitat improvements are needed, previously disturbed areas (logging decks, skid trails, previously established food plots) should be used (Department of the Air Force 1993). If food plots are located in or adjacent to these communities, aggressive species able to establish in natural communities should not be used (LeBlond, Fussell, and Braswell 1994a).

Timber management.

a. *Recommended.* "Existing natural forests should not be clearcut or converted to plantations. At sites not protected as natural areas, group selection or shelterwood management should be used. Stands that retain any native wiregrass cover should be managed for a somewhat open canopy. Prescribed burns should be the preferred method for site preparation and control of brush (LeBlond, Fussell, and Braswell 1994a)." This is consistent with the recovery plan for Chapman's rhododendron; the USFWS strongly recommends that fertilizer not be used in this community where it supports Chapman's rhododendron (USFWS 1983). Natural regeneration is the preferred method of longleaf pine establishment (Department of the Air Force 1993)

b. *Alternatives.* If natural regeneration of pine is not possible, hand planting containerized longleaf pine is preferable to machine planting (Department of the Air Force 1993). Clumps of trees should be left standing within artificially regenerated reforestation areas (Department of the Air Force 1993), to act as perch sites for seed dispersers.

Exotic species management.

Recommended. Reduction of feral hog populations should be a high priority at installations where they pose a problem. Cogon grass and other invasive exotic plant species should be treated as a threat to native plant communities, whether they occur in high-quality or low-quality examples, because their presence provides the potential for future invasion problems.

Native plants should be used in landscaping, and in revegetation measures when possible. If non-native cultivars must be used, then invasive species should be avoided (FNAI 1994).

Management of military activities.

a. *Recommended.* Pine flatwoods already benefit from frequent fires ignited by munitions training and testing (see Military activities). Mission-related fires should be allowed to burn into and through pine flatwoods to the greatest extent possible. If the community was managed only to maintain natural processes and maximize TES populations, no activities such as bivouacking, assembly, tactical land vehicle use or foot traffic would be allowed in this community or any adjacent upland communities.

b. *Alternative.* Drier pine flatwoods should preferentially be used over wetter pine flatwoods for any kind of military training—this will reduce damage from soil compaction, rutting, and channeling of water flow. Minor or neutral land use, such as transient foot traffic or low-intensity vehicle use, should be conducted during drier times of the year, and when TES plants and animals are not experiencing the stresses of harsh weather or reproduction. Frequent or extensive tactical land vehicle training will most likely result in hydrologic alterations to an extent that the community will no longer exist in a recognizable state. Bivouac and assembly sites will lead to large bare areas that take an extremely long time to recover (see Military activities). How far the negative impacts extend will depend on the topography and hydrology of the nearby areas. Current knowledge of pine flatwoods suggests that activities such as bivouacking and assembly be planned for fewer sites that are permanently altered and used, rather than many sites that are used in rest-recovery rotation. It is probable that the recovery phase will not be long enough to allow regeneration of the natural community.[1] When additional bivouac, assembly, or maneuver training sites cannot be avoided, care should be taken to minimize fragmentation of the larger community, so that landscape-level hydrologic processes and fire regimes are less impacted (see Land conversion).

Species that will be impacted negatively by this management and their management needs

Yellow anise tree (*Illicium floridanum*) may be impacted negatively by this management. Available information does not suggest that this is a fire-tolerant species, as it does not normally occur in fire-maintained communities (Kral 1983). This species occurs in disturbed pine flatwoods on the site of a former trailer park on NAS Jacksonville, FL, and the population is probably

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[1] Personal Communication, 12 May 1995, A. Weakley.

persisting from an ornamental planting (Environmental Services and Permitting, Inc., 1994).

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Appendix B
Department of Defense Installations in the Southeastern United States

Table B1
Department of Defense Installations in the Southeastern United States (Refer to Figure 2 (main text) for map of installation locations)

Code	Installation	State
Air Force		
F 6	Alabama ANGB	AL
F 12	Avon Park AFS	FL
F 3	Barksdale Air Force Base (AFB)	LA
F 14	Cape Canaveral (Port)	FL
F 20	Charleston AFB	SC
F 5	Columbus AFB	MS
F 24	Dare County Bombing Range	NC
F 7	Davidsonville Site	MD
F 18	Dobbins ARB	GA
F 21	Dover AFB	DE
F 9	Eglin AFB/Hurlburt Field	FL
F 1	Ellington Field AGS	TX
F 15	Homestead AFB	FL
F 4	Keesler AFB	MS
F 25	Langley AFB	VA
F 2	Little Rock AFB	AR
F 11	MacDill AFB	FL
F 8	Maxwell AFB	AL
F 16	Moody AFB	GA
F 13	Patrick AFB	FL
F 23	Pope AFB	NC
F 17	Robins AFB	GA
F 22	Seymour Johnson AFB	NC
F 19	Shaw AFB	SC
F 10	Tyndall AFB	FL
Army		
A 36	Aberdeen Proving Ground	MD
A 25	Alabama Army Ammunition Plant (AAP)	AL
A 11	Anniston Army Depot	AL
A 24	Camp McCain	MS
A 6	Camp Beauregard	LA
A 8	Camp Shelby	MS
A 7	Camp Villerie	LA
A 3	Camp Robinson	AR
A 20	Camp Frank D. Merrill	GA

(Sheet 1 of 3)

Table B1 (Continued)

Code	Installation	State
	Army (Continued)	
A 13	Camp Blanding	FL
A 29	Fort Detrick	MD
A 30	Fort Ritchie	MD
A 35	Fort Story	VA
A 28	Fort Lee	VA
A 5	Fort Polk	LA
A 26	Fort A.P. Hill	VA
A 27	Fort Picket	VA
A 2	Fort Chaffee	AR
A 14	Fort Stewart	GA
A 22	Fort Bragg	NC
A 10	Fort McClellan	AL
A 12	Fort Rucker	AL
A 21	Fort Jackson	SC
A 18	Fort McPherson	GA
A 19	Fort Gordon	GA
A 17	Fort Gillem	GA
A 16	Fort Benning	GA
A 15	Hunter Army Airfield	GA
A 31	Lone Star AAP	TX
A 32	Longhorn AAP	TX
A 33	Louisiana AAP	LA
A 23	Mississippi AAP	MS
A 4	Pine Bluff Arsenal	AR
A 1	Red River Army Depot	TX
A 9	Redstone Arsenal	AL
A 34	Sunny Point Military Ocean Terminal	NC
	Marine Corps	
M 4	Marine Corps Air Station (MCAS) New River (Helicopter)	NC
M 1	Albany MC Logistics Base	GA
M 3	Marine Corps Air Station Beaufort	SC
M 5	Marine Corps Base (MCB) Camp Lejeune	NC
M 6	MCAS Cherry Point	NC
M 2	Parris Island MC Recruit Depot	SC
M 7	Quantico MC Combat Development Command	VA
		(Sheet 2 of 3)

Table B1 (Concluded)		
Code	**Installation**	**State**
	Navy	
N 25	Annapolis Naval Station (NAVSTA)	VA
N 11	Cecil Field Naval Air Station (NAS)	FL
N 18	Charleston NAVSTA	SC
N 17	Charleston Naval Base	SC
N 20	Cheatham Annex NSC	VA
N 21	Dahlgreen Naval Surface Warfare Center	VA
N 4	Gulfport NCBC	MS
N 23	Indian Head Naval Ordinance Station	MD
N 12	Jacksonville NAS	FL
N 9	Key West NAS	FL
N 14	Kings Bay Naval Submarine Base	GA
N 13	Mayport NAVSTA	FL
N 6	Meridian NAS	MS
N 7	Mobile NS	AL
N 3	Naval Education and Training	FL
N 2	New Orleans NAS	LA
N 16	Norfolk NAVSTA	VA
N 19	Northwest NSGA, Chesapeake	VA
N 22	Oceana NAS	VA
N 10	Orlando Naval Training Center	FL
N 8	Panama City Naval Coastal Systems Center	FL
N 26	Pascagoula NAVSTA	MS
N 24	Patuxent River NAS	MD
N 15	Pensacola NAS	FL
N 5	Portsmouth NNSY	VA
N 1	Whiting Field NAS	FL
		(Sheet 3 of 3)

Appendix C
Matrix of Threatened and Endangered Plant Species and Species at Risk and the Installations on Which They Are Known To Occur

Table C1
Endangered and Threatened Plant Species and Plant Species at Risk and Installations in the Southeastern United States on Which They Are Known To Occur

Species	Rank	Installations of Occurrence Ordered by State																												
		AL (1)	AL (2)	AL (3)	AL (4)	AL (5)	FL (1)	FL (2)	FL (3)	FL (4)	FL (5)	FL (6)	FL (7)	FL (8)	FL (9)	FL (10)	GA (1)	GA (2)	GA (3)	GA (4)	GA (5)	LA (1)	MS (1)	NC (1)	NC (2)	NC (3)	NC (4)	SC (1)	VA (1)	VA (2)
Woody Plants																														
Anise tree, Yellow	SAR									X																				
Buckthorn	SAR																			X										
Butternut	SAR																						?							
Lead-plant, Georgia	SAR																									X				
Magnolia, Ashe's	SAR										X																			
Maricao Cimarron	SAR											X																		
Pondspice	SAR																			X				X			X			
Rhododendron, Chapman's	E							X																						
Spicebush, Bog	SAR										X												X			X				
Sumac, Michaux's	E																									X				X
White-wicky	SAR																									X				
Forbs																														
Amaranth, Seabeach	T																							X						
Aster, Chapman's	SAR										X																			

(Sheet 1 of 5)

Legend: Rank (Federal status rankings): E = endangered, T = threatened, SAR = species at risk. Alabama: AL (1) = Anniston Army Depot (ARMY), AL (2) = Fort McClellan (ARMY), AL (3) = Fort Rucker (ARMY), AL (4) = Redstone Arsenal (ARMY), AL (5) = NAS, Whiting Field OLF's in Alabama (NAVY). Florida: FL (1) = Avon Park AFB (AIR FORCE), FL (2) = Camp Blanding (ARMY), FL (3) = NAS, Pensacola and Outlying Field, Bronson (NAVY), FL (4) = NAS, Cecil Field (NAVY), FL(5) = Eglin AFB (AIR FORCE), FL (6) = NAS, Key West (NAVY), FL (7) = NAVCOMUNT, Saddlebunch Key (NAVY), FL (8) = NETPMSA, Saufley Field (NAVY), FL (9) = Tindall AFB (AIR FORCE), FL (10) = NAS, Whiting Field OLF's in Florida (NAVY). Georgia: GA (1) = MCLB, Albany (MARINES), GA (2) = Fort Benning (ARMY), GA (3) = Fort Gordon (ARMY), GA (4) = Fort Stewart (ARMY), GA (5) = Moody AFB (AIR FORCE). Louisiana: LA (1) = Fort Polk (ARMY). Mississippi: MS (1) = Camp Shelby (ARMY). North Carolina: NC (1) = MCB, Camp Lejeune (MARINES), NC (2) = MCAS, Cherrypoint (MARINES), NC (3) = Camp MacKall and Fort Bragg (ARMY), NC (4) = Su2nny Point MOT (ARMY). South Carolina: SC (1) = Fort Jackson (ARMY). Virginia: VA (1) = Fort A.P. Hill (ARMY), VA (2) = Fort Picket (ARMY).

Table C1 (Continued)

Species	Rank	Installations of Occurrence Ordered by State																												
		AL (1)	AL (2)	AL (3)	AL (4)	AL (5)	FL (1)	FL (2)	FL (3)	FL (4)	FL (5)	FL (6)	FL (7)	FL (8)	FL (9)	FL (10)	GA (1)	GA (2)	GA (3)	GA (4)	GA (5)	LA (1)	MS (1)	NC (1)	NC (2)	NC (3)	NC (4)	SC (1)	VA (1)	VA (2)
Forbs (Continued)																														
Aster, Coyote-thistle	SAR										X																			
Aster, Cruise's Golden	SAR										X																			
Aster, Godfrey's Golden	SAR								X		X				X															
Balduina, Purple	SAR																			X										
Barbara's Buttons, Mohr's	T		X																											
Bog Buttons, Tiny	SAR					X					X											X	X							
Bog-asophel, Smooth	SAR																							X		X				
Bogmint, Carolina	SAR																		X											
Boneset, Pine Barrens	SAR																									X				
Butterwort, Champman's	SAR								X		X				X	X							X							
Butterwort, Godfrey's	T														X															
Chaffseed, American	E																									X				
Coneflower, Bog	SAR																					X								
Coneflower, Smooth	E																											X		
Coneflower, Sunfacing	SAR																									X				
Coneflower, Yellow	SAR							X												X										
Cowbane, Piedmont	SAR																							X				X		
Cowlily, West Florida	E										X																			
Crownbeard, Chapman's	SAR														X															
Crownbeard, Variable-leaf	SAR							X		X																				
Eulophia	SAR						X	X												X		X				X		X		
Flax, West's	SAR										X																			

(Sheet 2 of 5)

Table C1 (Continued)

Species	Rank	Installations of Occurrence Ordered by State																												
		AL (1)	AL (2)	AL (3)	AL (4)	AL (5)	FL (1)	FL (2)	FL (3)	FL (4)	FL (5)	FL (6)	FL (7)	FL (8)	FL (9)	FL (10)	GA (1)	GA (2)	GA (3)	GA (4)	GA (5)	LA (1)	MS (1)	NC (1)	NC (2)	NC (3)	NC (4)	SC (1)	VA (1)	VA (2)
Forbs (Continued)																														
Goldenrod, Carolina	SAR																							X	X	X	X			
Goldenrod, Spring-flowering	SAR																								X	X				
Grass-of-Parnassus, Carolina	SAR																									X		X		
Groovebur, Incised	SAR																X	X		X			X							
Hartwrightia	SAR						X																							
Hoary-pea, Pineland	SAR										X																			
Jointweed, Large-leaved	SAR								X		X				X															
Lady's Slipper, Southern	SAR																					X								
Lily, Panhandle	SAR										X			X												X				
Lobelia, Boykin's	SAR																			X				X		X				
Loosestrife, Fraser	SAR		X																											
Loosestrife, Rough-leaved	E																							X		X	X	X		
Lupine, Golfcoast	SAR										X				X															
Meadowbeauty, Awned	SAR																							X						
Meadowbeauty, Panhandle	SAR										X																			
Mercury, Blodgett's Wild	SAR											X																		
Milk-vetch, Sandhills	SAR																									X				
Milkvine, Alabama	SAR										X																			
Milkweed, Southern	SAR														X															
Monkey-face	SAR		X																											
Morning-glory, Pickering's	SAR																	X	X							X				
Pigeon Wings	T						X																							

(Sheet 3 of 5)

Table C1 (Continued)

Species	Rank	AL (1)	AL (2)	AL (3)	AL (4)	AL (5)	FL (1)	FL (2)	FL (3)	FL (4)	FL (5)	FL (6)	FL (7)	FL (8)	FL (9)	FL (10)	GA (1)	GA (2)	GA (3)	GA (4)	GA (5)	LA (1)	MS (1)	NC (1)	NC (2)	NC (3)	NC (4)	SC (1)	VA (1)	VA (2)
		Installations of Occurrence Ordered by State																												
Forbs (Continued)																														
Pitcher Plant, White-topped	SAR					X			X		X			X		X														
Pixie-moss, Well's (sandhill)	SAR																									X				
Pondweed	SAR																									X				
Price's Potato-bean	T				X																									
A Queen's Delight	SAR							X																						
Rosinweed, Cumberland	SAR				X																									
Small Whorled Pogonia	T																												X	
Spurge, Porter's	SAR												X																	
Swamp Pink	T																												X	
Trillium, Relict	E																	X												
Venus' Fly-trap	SAR																									X	X			
Water Milfoil, Piedmont	SAR																							X		X	X	X		
Wild Indigo, Hairy	SAR										X					X														
Wireweed	E						X																							
Yellow-eyed Grass, Drummond's	SAR										X				X							X								
Yellow-eyed Grass, Harper's	SAR										X				X							X	X			X				
Yellow-eyed Grass, Quillwort	SAR														X															
Yellow-eyed Grass, Tennessee	E	X	X																											
Grasses, Rushes, and Sedges																														
Beaked-rush, Decurrent	SAR						X																							
Beaked-rush, Hairy-peduncled	SAR										X															X				

(Sheet 4 of 5)

Table C1 (Continued)

Species	Rank	Installations of Occurrence Ordered by State																												
		AL (1)	AL (2)	AL (3)	AL (4)	AL (5)	FL (1)	FL (2)	FL (3)	FL (4)	FL (5)	FL (6)	FL (7)	FL (8)	FL (9)	FL (10)	GA (1)	GA (2)	GA (3)	GA (4)	GA (5)	LA (1)	MS (1)	NC (1)	NC (2)	NC (3)	NC (4)	SC (1)	VA (1)	VA (2)
Grasses, Rushes, and Sedges (Continued)																														
Bluestem, Scrub	SAR						X																							
Dropseed, Pinebarrens	SAR																							X						
Grass, Cuthroat	SAR						X																							
Grass, Curtis' Sand	SAR										X					X														
Grass, Southern Three-awned	SAR										X												X							
Jointgrass, Piedmont	SAR						X																							
Panic Grass, Hirst's	SAR																							X						
Panic Grass, Naked-stemmed	SAR										X												X							
Sedge, Baltzell's	SAR										X																			
Sedge, Chapmans's	SAR																							X	X					
Sedge, Umbrella	SAR																					X								
Lichens																														
Cladonia, Florida Perforate	E										X																			

(Sheet 5 of 5)

Appendix D
List of Federal Offices Solicited for Review of Draft Strategic Environmental Research and Development Program Report

List of Federal Offices Solicited for Review of Draft SERDP Report

Office of the Deputy Undersecretary of Defense ATTN: ODUSD(ES)CI 400 Army-Navy Drive, Suite 206 Arlington, VA 22202-2884	Office of the Director of Environmental Programs Department of the Army ATTN: DAIM-ED-N 600 Army Pentagon Washington, DC 20310-0600
Office of the Deputy Chief of Staff for Operations and Plans, Department of the Army ATTN: DAMO-TRO 400 Army Pentagon Washington, DC 20310-0400	Planning Division U.S. Army Corps of Engineers ATTN: CECW-PD 20 Massachusetts Avenue, NW Washington, DC 20314-1000
Army Environmental Policy Institute Georgia Institute of Technology ATTN: AEPI 430 Tenth Street, NW, Suite S-206 Atlanta, GA 30318-5768	Directorate of Research and Development U.S. Army Corps of Engineers ATTN: CERD-M 20 Massachusetts Avenue, NW Washington, DC 20314-1000
U.S. Army Environmental Center Conservation Division ATTN: SFIM-AEC-EC Aberdeen Proving Ground, MD 21010-5401	Naval Facilities Engineering Command Department of the Navy 200 Stoval Street (Code 143) Alexandria, VA 22332-2300
Headquarters, U.S. Air Force ATTN: CEVP 1260 Air Force Pentagon, Room 5B269 Washington, DC 20330-1260	U.S. Army Training Support Center ATTN: ATIC-CTS Fort Eustis, VA 23604
HQ, Marine Corps ATTN: LFL 2 Navy Annex Washington, DC 20380	U.S. Army Cold Regions Research and Engineering Laboratory ATTN: CECRL-RE 72 Lyme Road Hanover, NH 03855-1290

(Continued)

(Concluded)	
U.S. Army Topographic Engineering Center Humphreys Engineering Center ATTN: CETEC 7701 Telegraph Road Alexandria, VA 22310-3864	U.S. Army Construction Engineering Research Laboratories ATTN: CECER-EL P.O. Box 9005 2902 Newmark Drive Champaign, IL 61826-9005
HQ, Forces Command Department of the Army ATTN: AFPI-ENE Fort McPhearson, GA 30330-6000	Environmental Protection Specialist HQ, U.S. Army Pacific ATTN: APEN-EV Fort Shafter, HI 96858-5100
Environmental Programs Directorate National Guard Bureau ATTN: NGB-ARE 111 S. George Mason Drive Arlington, VA 22204-1382	HQ, Army Materiel Command Department of the Army ATTN: AMSMC-EHR Rock Island, IL 61299-6000
HQ, Training and Doctrine Command Department of the Army ATTN: ATBO-FN Fort Monroe, VA 23651	HQ, Army Materiel Command Installations and Services Command ATTN: AMXEN-U Rock Island, IL 61299-7190
USDI Fish and Wildlife Service Division of Endangered Species ATTN: MS 452 ARLSQ 1849 C Street, NW Washington, DC 20240	USDA Forest Service Wildlife, Fish, and Rare Plants P.O. Box 96090 Washington, DC 20090-6090
U.S. Department of Energy Environmental Services Division, ER-74 Office of Health and Environmental Research Washington, DC 20585	National Marine Fisheries Service Office of Protected Resources, F/PR 1335 East-West Highway Silver Spring, MD 20910-3226
Environmental Protection Agency 410 M Street, SW (code 2252) Washington, DC 20460	USDI Bureau of Land Management Wildlife-Fisheries Division (WO-240) 1849 C Street, NW (LRS 204) Washington, DC 20240
National Biological Service Division of Research ATTN: MS 725 ARLSQ 1849 C Street, NW Washington, DC 20240	USDI Bureau of Reclamation P.O. Box 25007 (D-5724) Denver, CO 80225
USDA National Park Service Division of Wildlife/Vegetation Endangered Species Program 800 W Capitol Street, NW Washington, DC 20001	Natural Resources Conservation Service Ecological Services Division P.O. Box 2890 Washington, DC 20013-2890

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13. ABSTRACT *(Maximum 200 words)*

The conservation and management of threatened and endangered species (TES) and their habitats are major concerns on Department of Defense (DoD) lands nationwide. Historically, most DoD efforts regarding TES have been conducted on a species-by-species basis on separate installations. However, there has been a recent policy shift within DoD toward ecosystem-based management methods that address multiple species rather than a single species. This report describes a plant community-based, multispecies approach to TES management as part of the DoD Strategic Environmental Research and Development Program. This approach emphasizes (a) regional and community-based strategies, (b) methods that apply collectively to groups of species within a region, and (c) use of consistently reliable methods. The southeastern United States was selected for developing a prototype management plan because this region contains a large number of installations that have TES concerns.

Plant community abstracts are being prepared for major plant communities occurring on southeastern installations. An example plant community abstract is provided that includes a description, impacts to the community, and detailed management information. To complement abstracts, "Species Profiles" are being developed for selected animal TES occurring in these plant communities. A survey is also being conducted on potential impacts of military activities on plant communities. The prototype management plan will be used as a basis for developing additional management plans for other U.S. regions.

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